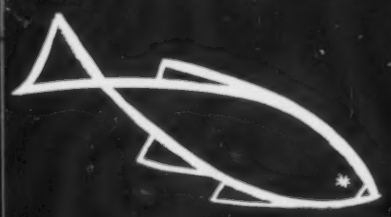
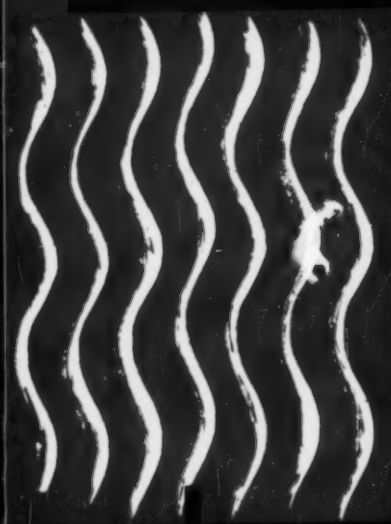
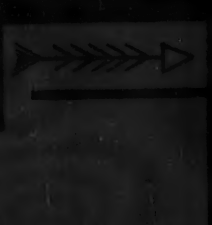
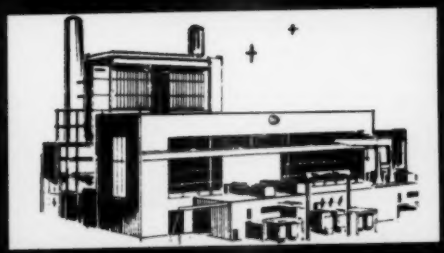
Power Engineering®

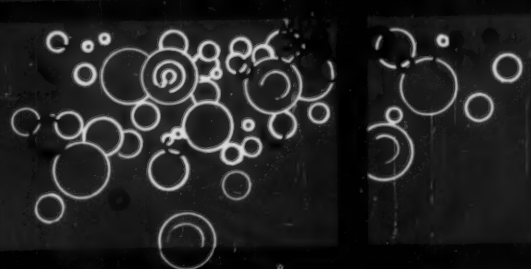


DECEMBER 1961









HOW SERIOUS IS PLANT THERMAL POLLUTION?

FIRST SIMPLIFY...

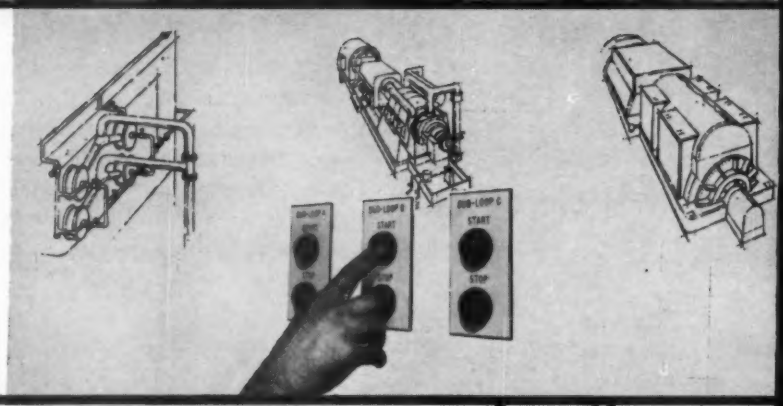
First step to automation is to *simplify* the information now presented by a multitude of multi-record charts, gages, and annunciator lights. The Bailey approach gives the operator data he needs (logged periodically), keeps continuous watch on all variables, makes calculations where required, alarms when trouble threatens.

Bailey 700 Systems draw on the best available techniques, including analog and digital manipulation, trend recording, time sharing, scanning, alarming, calculating, controlling, and logging, as required to meet operating objectives.

Reliability of recorded data is increased . . . operators can devote full attention to correcting off-normal conditions and improving operations. The system may include frequent performance calculations showing the contributions of each portion of the cycle to over-all performance so that faults and deterioration may be spotted and corrected.

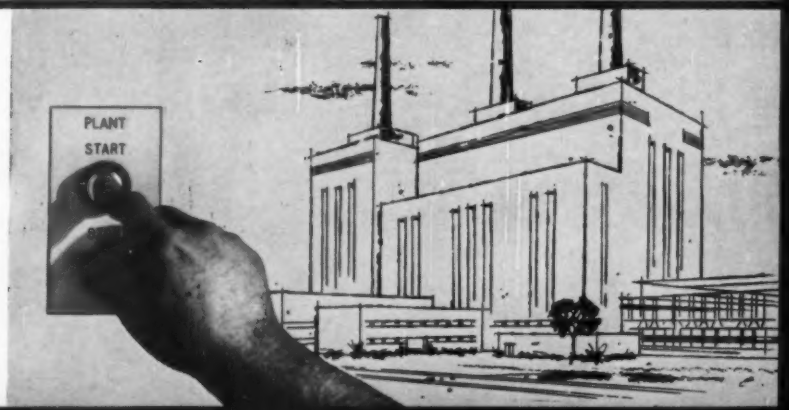
NEXT VERIFY...

Next verify the practicability of automation by extending supervisory controls, letting equipment perform more operating functions. Automate key systems, one at a time, by push-button-controlled subloops. This approach smooths the transition to complete automation.



THEN AUTOMATE

Final steps are: (1) consolidate supervisory controls, conventional controls, and subloops for full-range automatic operation once the plant has been placed on the line; and (2) add start-stop control to provide full automation.



first Simplify...

NEXT VERIFY...
THEN AUTOMATE

Bailey verified steps to automation mean benefits now... and increasing benefits as you go

Automation need not be an all-out commitment. Between today's conventional power-station control and the ultimate in automation are step-by-step advantages that can be gained—as individual problems are resolved.

This permits the final investment commitment only after satisfactory evidence that it is economically justified and practicable.

Bailey Systems concepts are embodied in the approach, "First simplify — next verify — then automate". The steps outlined here coordinate the best available techniques, including analog and digital, in Bailey 700 Systems designed — and expanded as desired — to the needs of the individual plant. They may be undertaken singly, in combination, or in entirety. System elements are composed of solid-state electronic modules providing the ultimate in reliability and flexibility.

Bailey 700 Systems are in operation today —or on order for installation—from coast to coast and all over the world. Ask your Bailey Engineer, or write for details. Bailey Meter Company, 1040 Ivanhoe Road, Cleveland 10, Ohio. In Canada -- Bailey Meter Company Limited, Montreal.

System concepts founded on 45 years of experience

21 out of 26 of today's "most efficient" steam-electric stations in the United States use Bailey Instruments and Controls*. This reflects the more than 45 years of Bailey developments devoted to improving the reliability of power-plant operation. These developments include experience in automation, dating from electrically operated boiler controls in 1924 and automatic start of boiler controls on steam-electric locomotives in 1936, to systems installations in operation, or under construction today, from coast to coast and throughout the world.

**Listed in Federal Power Commission Report S-143.* A 166-2

BAILEY METER COMPANY

700 Systems

For more data circle 501 on Post Card

B-E-H mono-block®

delivers higher insulating efficiency at lower installed cost

Any way you figure it, you'll get a better job at lower cost with Mono-Block. Thickness for thickness, Mono-Block delivers more margin of protection than most other block insulations. And because it's so much easier to handle, so much faster to apply, installation costs on Mono-Block go down by as much as 15% to 20%.

Higher Maintained Efficiency! The patented B-E-H manufacturing process assures greater integrity of binder and mineral fiber... provides longer periods of peak efficiency at high temperatures.

Lower Installed Cost! On any installation, large or small, Mono-Block delivers these outstanding engineering advantages: 1. Easy cutting for perfect fit . . . straight, odd-shaped, mitered, angled or curved. 2."Push-over" impaling on studs or pins... without drilling holes. 3. Two by three foot blocks mean faster coverage, easier handling... and Mono-Block's strength reduces possible damage when installing. 4. Mono-Block's built-in "give" allows it to fit snugly over projections, without cracking or breaking. The outer surface stays flat and smooth.

At Your Service! For technical data and service, call your local B-E-H contractor. For engineering assistance — from information to installation — write Baldwin-Ehret-Hill, Inc., Room 303, 500 Breunig Ave., Trenton 2, N. J.

BEH BALDWIN-EHRET-HILL

BALDWIN-EHRET-HILL, Inc.

Manufacturers of a complete line of pipe, block, felt and blanket insulation for temperatures from near absolute Zero to 2100 F.

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Comment

The tremendous growth in utility and industrial plants, along our rivers, has created a new problem of national interest — THERMAL POLLUTION.

Our search for an authority on this problem produced Richard D. Hoak of Mellon Institute. His article, in this issue of Power Engineering, is of interest to all those concerned with plant site selection. Increasing need for cooling water places greater importance on the use of cooling towers — both conventional and hyperbolic.

Bob McCaw

EDITOR

Power Engineering®

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ON THE COVER

Greater use of our rivers for cooling-water sources is creating serious problems in Thermal Pollution, which affects normal growth of fish and wildlife. See the article beginning on page 39.

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around the power circuit

Computer technicians make final check on Honeywell 800 EDP system before shipping to Philadelphia Electric Co. Seen here is part of the battery of high-speed magnetic tape drives included in the large-scale system

MAMMOTH steam-generating boiler to power its record-breaking 1,000,000-kw turbine-generator has been ordered by Con Edison. The electric generating facility will be located adjacent to Con Edison's East River generating station at the foot of 14th Street, New York City. The $131-million installation is scheduled for operation in 1966.

The boiler will be designed, manufactured, and erected by Combustion Engineering, Inc. A feature of the design will be division of the boiler into two sections so that the electric generator unit can be operated at half power even though one section of the boiler is shut down.

The unit will be designed to burn pulverized coal or oil. When operated at peak load about 350 tons of coal will be burned in the boiler every hour. The unit will be capable of turning 6,500,000 pounds of water into 2400-psi, 1000-F steam every hour.

Mechanical and electrostatic precipitators will remove more than 99 per cent of the flyash.

MOBILE SUBSTATION with a record rating of 25,000 kva, topping the previous industry high of 22,000 kva, will be built by GE for Gulf States Utilities Co. The mobile's voltage will be 138 kv.

The unit will be a complete substation, consisting of a high-voltage disconnecting switch, lightning arresters and fuses, three-phase forced-oil-cooled power transformer, low-voltage switchgear and control and relaying equipment.

A HONEYWELL 800 large-scale electronic computer has been shipped from Minneapolis-Honeywell to Philadelphia Electric Co. The computer will be installed at the power company's main service building in mid-city Philadelphia. It will be used there to automate the billing of the utility's 1.1 million customers, to help solve intricate engineering problems related to a constant and economic supply of electric power, and for general accounting.

In the engineering area, the new computer will work on load-flow studies. It will be used also on engineering studies of short circuits and relays, transmission line impedance, cable temperatures, equipment ratings, network analysis and reduction, heat rate and load surveys, steam station performance, gas load analysis, capital recovery analysis and engineering cost accounting.

NATION'S LONGEST span aluminum crane will be made by Milwaukee Crane Division of Novo Industrial Corp. It will be used in outdoor service by the Public Service Electric & Gas Co. This is the third aluminum crane purchased by Public Service from this firm.

GROUND has been broken for Plant Harllee Branch, Georgia Power Co.'s newest steam-electric generating plant. Site of the plant is on the company's 15,000-acre Lake Sinclair and directly west of the Little River crossing of the Milledgeville-Eatonton highway. Generating capacity of the initial unit of the plant is scheduled for 250,000 kw.

When Plant Harllee Branch begins production in 1965, the Georgia Power Co. will have 29 generating stations and a total capacity of more than 2,700,000 kw.

UNIVERSAL PRESSURE once-through boiler system will be recommended for all electric utility boiler applications requiring turbine throttle pressures of 2000 psi and higher, Babcock & Wilcox vice-president S. T. Mackenzie announces.

The high-temperature, high-pressure boiler system developed by B&W has proved to be the most economical for these service conditions, Mackenzie claims. In the past four years, 16 of the new units have been installed or ordered for utility plants, which represent a total industry investment of almost $1 billion and a generating capacity of over 6,450,000 kw.

A BRAZILIAN hydroelectric agency has placed a record order for 24 General Electric 345,000-v power transformers, rated from 50,000 to 225,000 kva.

Central Electrica de Furnas will use the transformers to supply up to 1,200,000 kw to local utilities serving Rio de Janeiro, Sao Paulo and Belo Horizonte and other cities.

Continued on page 6

site for a town that drinks nothing but SEA

Sun-baked desert, parched and waterless — not a very promising site for a town. But, with the development of the Richardsons Westgarth multi-stage vacuum flash sea-water evaporator, it is now economically feasible for towns in arid coastal countries to draw all their fresh water from the sea.

These evaporators were pioneered in Great Britain by Richardsons Westgarth. The largest of them could distill 2,000,000 gallons of sea-water a day — enough for a town of 250,000 inhabitants — and the distillate is purer than many mains water supplies from conventional sources.

Richardsons Westgarth evaporators are at work in South America, the Middle East and elsewhere, providing fresh water for both domestic and industrial applications.

These units are at their most economical when used in conjunction with low-pressure steam or back-pressure turbines and, as manufacturers of most of the major equipment for power generation, Richardsons Westgarth are particularly well qualified to carry out completely integrated schemes.

R W G

RICHARDSONS, WESTGARTH & CO. LTD.

The Controlling Company of the Richardsons Westgarth Group,
Wallsend, Northumberland, England, *and at 58 Victoria Street, London, S.W.1.*

For more data circle 503 on Post Card

This south-central area of Brazil consumes 80 per cent of the country's electrical energy.

The Furnas development is centered around a dam on the Grande River 250 miles northwest of Rio de Janeiro and is one of several new projects playing key roles in Brazil's program to increase generating capacity from three million kw in 1955 to eight million in 1965.

around the power circuit

AUSTIN UTILITIES of Austin, Minn., has installed a 5500-kw Westinghouse gas turbine for future combined-cycle operation. Initially used for peaking service, the gas turbine will later be combined with a 22,000-kw steam turbine and will also be used for the feedwater heating of the other machines in the station.

Ultimate station capacity would be 47,185 kw with the gas turbine exhaust heat fully utilized. It is reported the combined-cycle system will represent a reduction in fuel consumption of approximately 15.2 per cent as compared to a conventional steam plant.

AN ALL-OUT EFFORT on the part of Washington Public Power Supply System to bring about the addition of power-generating facilities to the new Hanford plutonium production reactor by the federal government, or, if economically feasible, by a non-federal agency, has been authorized by the executive committee of the Supply System.

PLANNING GUIDE for observing National Electrical Week, Feb. 11-17, 1962, is now available. Write St. Louis N.E.W. headquarters, suite 306, 407 N. 8th St., St. Louis 1, Mo.

DETAILS of the Bureau of Reclamation's $271.5-million fiscal year 1962 construction program have been announced. As an end result of this program, the nation is expected ultimately to gain about 44,962,000-acre-feet of vitally needed reservoir storage capacity in the 17 Western States, 1,857,900 kw of hydroelectric capacity, a full water supply for irrigation of 1,463,000 acres, and a supplemental water supply for 836,600 acres of farmland.

FIRST STEPS to consider consolidation of the American Institute of Electrical Engineers and the Institute of Radio Engineers have been taken. In a resolution passed by the boards of directors of both societies, a committee has been formed to determine the feasibility and form of such consolidation.

The committee is to submit a report to the boards of both societies not later than February 15, 1962, for their approval, "with a view to submission to a vote of the memberships of the two Institutes and consummation, if so approved, by January 1, 1963."

The proposed new organization would be international in scope and involve 150,000 engineers, scientists, educators and industrialists.

GENERAL ELECTRIC CO. has begun operation of a new laboratory at its Burlington, Vt., plant, devoted solely to developing ways to extract fresh water from the sea. The facility will serve as the company's engineering center for sea water and brackish water distillation work.

DURING 1961 the nation's electric power industry will increase its generating capability by 13 million kw, reaching a total of 187.9 million kw by the end of the year. This is reported in the 30th semiannual electric power survey of the Edison Electric Institute.

This year's addition to U.S. generating capability represents an increase of 7.5 per cent over the actual capability of 174.9 million kw at the end of 1960, the survey shows. By the end of 1964, total capability is predicted at 221.4 million kw.

The December 1961 peak load for the total electric utility industry is expected to reach 144.1 million kw, an increase of 8.3 per cent over last year's December peak of 133 million kw. By the end of 1964, peak load for the total industry is expected to reach 177.4 million kw.

ABOUT 95.3 MILLION KW of potential hydroelectric power capacity was available for possible development in the United States as of January 1, 1960, according to the Federal Power Commission. This undeveloped capacity would have an average annual generation of about 361.7 billion kwh.

Fifty-six per cent, or about 53.6 million kw, was in river basins west of the Continental Divide; 33,187,600 kw of this in the Columbia River Basin. The Columbia River, with its tributaries, had the largest amount of undeveloped power of any river system in the country. The main stem had undeveloped power estimated at 10,726,600 kw and five of its tributaries had over one million kw each.

As of January 1, 1960, the installed capacity of utility hydroelectric plants was 3.118,331 kw.

NEW SHOCK TREATMENT method of milk sterilization has been developed by a team of researchers at Alnarp, the Swedish University College of Dairy Engineering, in collaboration with AB Separator, the Swedish Alfa-Laval Co. Milk processed according to this method can be stored at least four weeks at temperatures normal in the tropics without any change of flavor, color or nutrition value, it is claimed.

In the new process the milk is preheated and then given a shock treatment by being heated to 140 C (284 F) by jets of hot steam, then quickly chilled by evaporation in a vacuum chamber. This vacuum processing also frees the milk from any feed or similar taste. Milk obtained by this process is absolutely sterile, and thus is suitable for prolonged keeping.

AMERICAN SOCIETY for Testing and Materials' 1960 Proceedings, volume 60, is now available. This 1242-page volume is the official record of the proceedings of the Society for the entire year. Copies may be obtained from the Society at 1916 Race St., Philadelphia 3, at $12 each.

Maintenance and Steam Traps

. . . there's a relationship that goes far beyond trap maintenance alone

Good traps and good trapping have a greater effect on your maintenance costs than does trap maintenance itself. By that we mean that the right traps, properly selected and installed, and with the benefits of a preventive maintenance program, will save far more maintenance dollars than they will cost.

Under the pressure of spiralling maintenance costs, this thought becomes mighty important. Let's take a look at what it involves:

Proper Selection of Steam Traps

1. Be sure it's the right type of trap.

2. Be sure it's sized right and is for the correct operating pressure.

3. Be sure it's first rate in design and construction.

Proper Installation of Steam Traps

1. Install them so they are accessible for inspection and maintenance.

2. Install a test valve.

3. Use a union or unions.

4. Use a shutoff valve or valves.

5. Use a strainer ahead of the trap if dirt conditions are bad.

6. Use a by-pass only where continuity of service is imperative.

7. Standardize inlet and outlet connections.

Preventive Maintenance Program

1. Test trap regularly for proper operation. (Trap size, operating pressure and importance determine frequency.)

2. Inspect internal mechanism at least once a year.

You Get Indirect Benefits As Well

The direct benefits of the plan outlined are pretty obvious — good traps, properly selected, require less maintenance . . . testing and inspection prevents troubles that lead to maintenance.

However, this plan provides indirect benefits which reduce maintenance in other parts of the plant as well:

Good traps save steam and reduce the load (and consequently maintenance) on fuel handling and burning equipment and on ash handling equipment.

Good traps protect the system by eliminating water hammer and preventing the damage it can do.

Good traps discharge carbon dioxide before it can go into solution to form corrosive carbonic acid — less corrosion, less maintenance.

Good traps increase production to reduce the length of time equipment must operate or reduce the amount of equipment needed . . . either way maintenance is reduced.

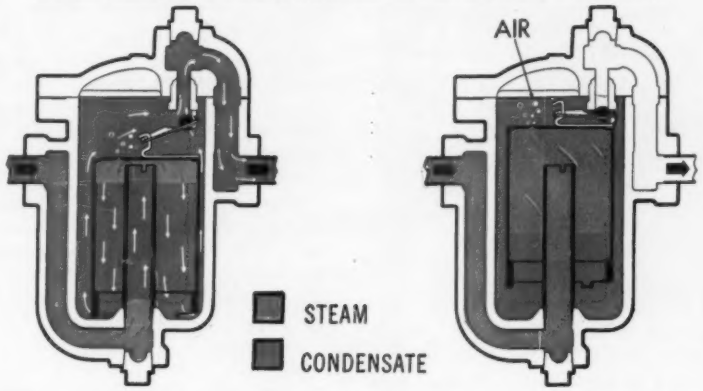
How to Go About It (The Sales Pitch)

We admit we're prejudiced, but we don't think there is any better way to select steam traps than with the help of the 44 page Armstrong Steam Trap Book. Here in a single source is specific data on the selection and sizing of traps, how to install them for best results, and how to maintain them most economically.

The Steam Trap Book will also give you full information on the design and construction of Armstrong Inverted Bucket Steam Traps that offer these important maintenance-reducing advantages:

1. Armstrong Traps are dependable.

HERE'S THE STEAM TRAP DESIGN THAT CAN REDUCE YOUR MAINTENANCE PROBLEMS



Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

2. Armstrong Traps require no adjustments — go from full load to zero load automatically.

3. Armstrong Traps are self-scrubbing—ordinary dirt conditions can't hurt them.

4. Armstrong Traps have long-life parts — valve and seat are heat treated chrome steel — lever assembly and bucket are stainless steel.

5. Armstrong Traps have water sealed valves to minimize wire drawing and erosion.

Ask for your copy of the Steam Trap Book—there is no obligation. Then test Armstrong Trapping. If you are not completely satisfied with the results, you can return the traps for a full refund of the purchase price. You can't lose much that way. Call your local Armstrong Representative or Distributor, or write

Armstrong Machine Works
8109 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

See our catalog in Sweet's Plant Engineering File

For more data circle 504 on Post Card

who

Robert P. Saar has been appointed vice-president, manager-engineering, for Henry Pratt Co. Saar was formerly chief engineer of the company.

C. A. "Can" Nordquist has been named planning engineer — utility marketing for I-T-E Circuit Breaker Co. Nordquist has been associated with the sale and application of I-T-E products in the Chicago area for 33 years.

Dr. W. E. Johnson has been named manager of the Westinghouse atomic power department.

J. Harris Ward has succeeded **Willis Gale** as chairman of Commonwealth Edison Co. Mr. Gale will continue in active service with Commonwealth as chairman of the executive committee. Mr. Ward will continue to serve also as president of the utility.

Mervin J. Kelly, former chairman of the board of Bell Telephone Laboratories, has received the 1961 Hoover Medal for "distinguished public service."

Lloyd M. Griffin has been elected vice-president of Public Service Company of Indiana. He will be in charge of the company's Southern Division, with headquarters at Columbus.

Charles R. Ross, of Burlington, Vt., former chairman of the Vermont Public Service Commission, has taken office as a member of the Federal Power Commission for the term expiring June 22, 1964.

Albert V. Crewe has been selected as the new director of Argonne National Laboratory, succeeding **Norman Hilberry**. Crewe, who was born February 18, 1927, at Bradford, Yorkshire, England, is an authority on atom-smashing. He has been the head of Argonne's Particle Accelerator Division since Sept. 1958.

Robert N. Miers, 59, consultant to Allis-Chalmers' thermal power department, died October 15. Mr. Miers had been associated with Allis-Chalmers' steam turbine department since 1928.

Clyde C. Ruffle has been promoted from managerial assistant to assistant to general manager, Electric Department, Public Service Electric and Gas Co. He succeeds **Herbert Wottrich**, who is retiring.

E. L. Barth, secretary-treasurer of Metropolitan Edison Co., has been elected to the board of directors. Next May, Mr. Barth will mark 50 years of service with MECO and its associated and affiliated companies, making him the company's senior employee in point of service.

what

Coal constitutes 68 per cent of the total recoverable reserves of mineral fuels in the United States, according to a new Geological Survey report. Petroleum and natural gas total about 16 per cent of the fossil fuel reserves, and oil from oil shale accounts for another 16 per cent.

Estimated recoverable coal reserves of the nation totaled 830 billion tons as of January 1, 1960. Of this huge tonnage, some 1442 times the recent annual production, 47 per cent is bituminous, 25.5 per cent is sub-bituminous, 26 per cent is lignite and 1.5 per cent is anthracite and semi-anthracite. These reserves will last many generations.

We're sorry for the boner in our November issue. In the printing process, the captions were transposed on pages 62 and 63. Actually, Messrs. Bremner, Lorenz and Guthrie are pictured on page 63 while Messrs. Hally, Duncan and Towne are pictured on page 62 of the EEI T&D Committee meeting report.

when

AIEE's Winter General Meeting and Exposition wil be held Jan. 29-Feb. 2, 1962, in New York City.

Semiannual meeting of the American Society of Heating, Refrigerating and Air Conditioning Engineers will be held Jan. 29-Feb. 1, 1962 at the Chase Park Plaza Hotel, St. Louis, Mo.

Fifth biennial National Industrial Electric Heating Conference is set for Feb. 5-8, 1962, at the Netherland Hilton Hotel in Cincinnati.

Seventh annual Gas Turbine Conference and Products Show will be held at the Shamrock Hilton in Houston, Texas, March 5-8, 1962. Sponsored by ASME's gas turbine power and process industry divisions.

Second National Electric Comfort Heating Exposition and Symposium is scheduled for next March 19-21, at the Hotel Sherman in Chicago. Sponsored by the National Electrical Manufacturers Assn.

The biennial Electrical Industry Show and Conference, sponsored by the Electrical Maintenance Engineers Assn. of California, will be held March 28-31, 1962, in Los Angeles.

GET LOW-COST DEPENDABLE PROTECTION FOR LOW PRESSURE BOILERS WITH AN H20® CHEMICAL METERING PUMP

Benefits include lowest cost ever, a new record for low maintenance requirements, and easier servicing. The H20 controlled volume pump not only costs less to purchase and install, but it costs less to operate at the peak of efficiency than any other comparable chemical feeder. The H20 metering pump is based on the same principles that have made Milton Roy controlled volume pumps famous. But in the interests of economy, every working part has been simplified and redesigned for production line manufacturing. There's been little sacrifice in accuracy, and none at all in dependability.

Around the clock, you can depend on your H20 pump to meter the necessary mild, non-corrosive treatment chemicals to your boiler feed, cooling tower and process make-up water. The H20 is available immediately from stock. Even completely piped and assembled chemical feed systems with simplex or duplex H20 pump and 50 to 100 gallon steel tank can be shipped within 24 hours. They're ready to go to work immediately, accurately and economically metering chemicals against pressures to 600 psi.

GET COMPLETE FACTS *on the H20 pump and packaged chemical feed systems in Bulletin 558. Write Milton Roy Company, 1300 East Mermaid Lane, Philadelphia 18, Pennsylvania.*

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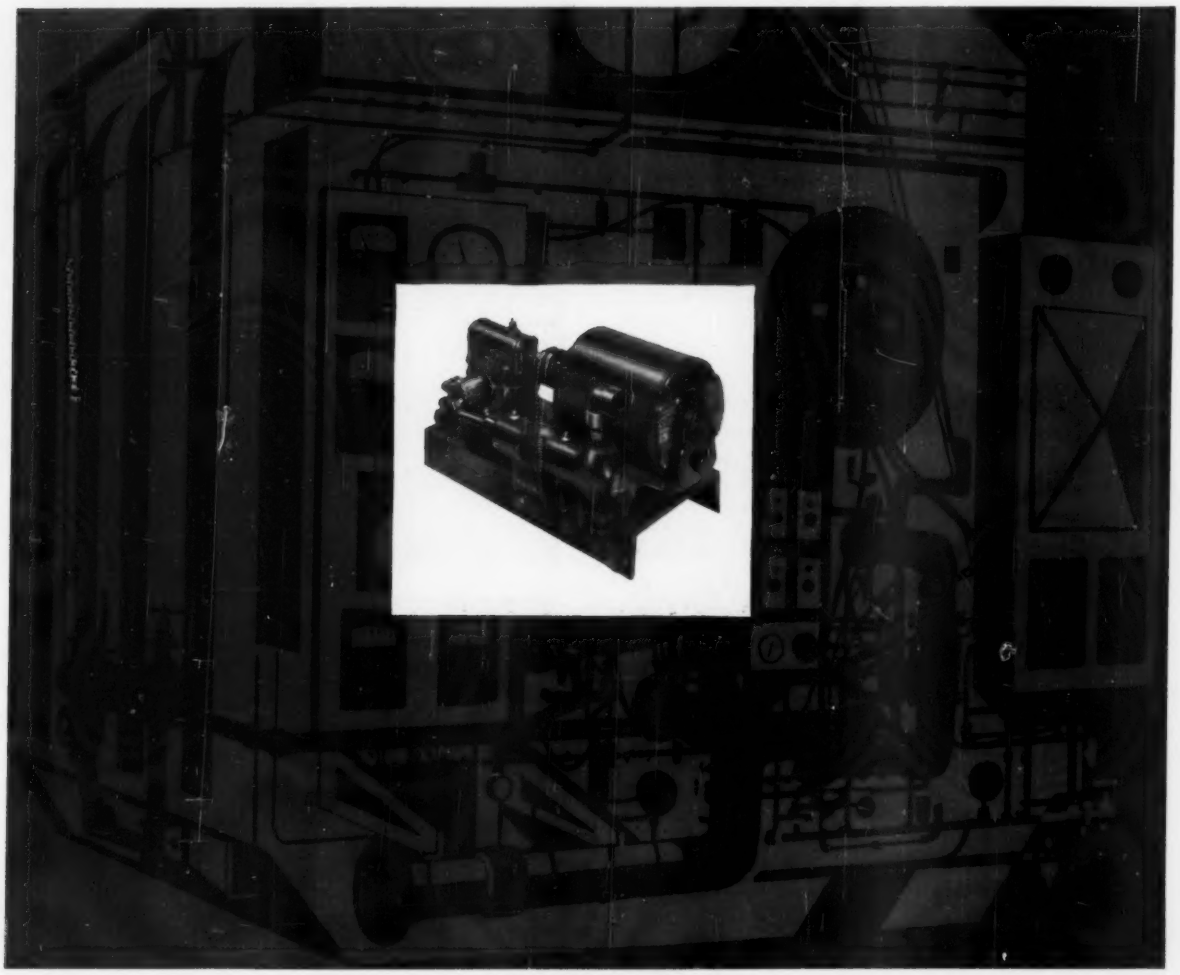

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EASTERN OFFERS MORE THAN COAL

Coal buyers who look for the most for their fuel dollar know that a given coal has certain specific characteristics. They also know that the full value of the coal depends on the organization that produces it. Such extras as on-time delivery, consistent adherence to contract specifications, ready assistance in solving a complex fuel problem . . . all these and many others are of even more importance. That's why Eastern Gas and Fuel Associates stress the "extras" that are a part of every ton of coal they sell.

Call your Eastern representative for full information on how Eastern Gas and Fuel Associates can help you to make your fuel program more efficient, effective and economical.

RESERVES—Eastern Gas and Fuel Associates' properties include coals from the Pocahontas, Pittsburgh, Eagle, Hernshaw and many other well-known and desirable seams. Their total reserves will satisfy present production rates for more than one hundred years, and Eastern is constantly on the alert to acquire additional desirable acreage.

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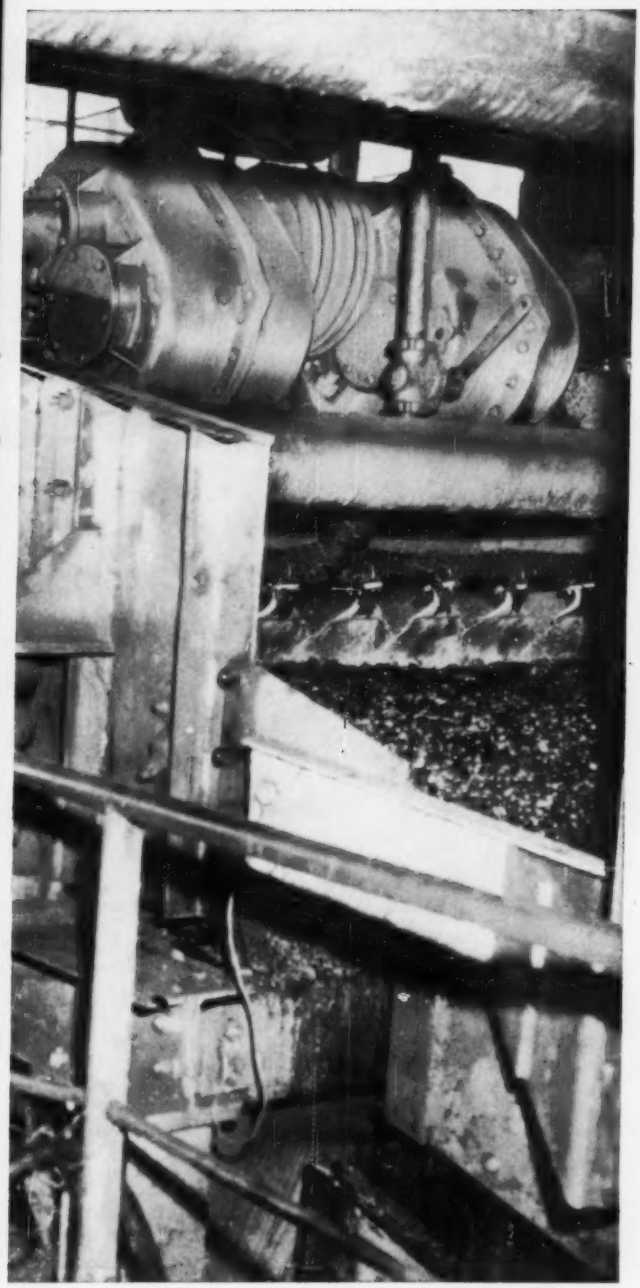
BOSTON • BUFFALO • CINCINNATI • CLEVELAND • DETROIT • NEW YORK
NORFOLK • PHILADELPHIA • PITTSBURGH • SYRACUSE



QUALITY—By the application of the most modern mining and coal preparation techniques, Eastern is in a position to meet requirements for specific types, sizes and grades of coal for both steam and metallurgical use. Eastern's modern preparation plants produce coals that are cleaned, sized and graded—coals *engineered* to suit your specific needs.

SERVICE/RESEARCH—Eastern's service is backed by a customer-oriented research program. While Eastern did not invent coal research, they established the *first* coal company research laboratory, and have made research an integral part of all their operations. Eastern's service includes basic research, close cooperation with customer engineering staffs, an integrated program of information exchange with equipment manufacturers and a tremendous backlog of technical information on present and potential uses of coal.

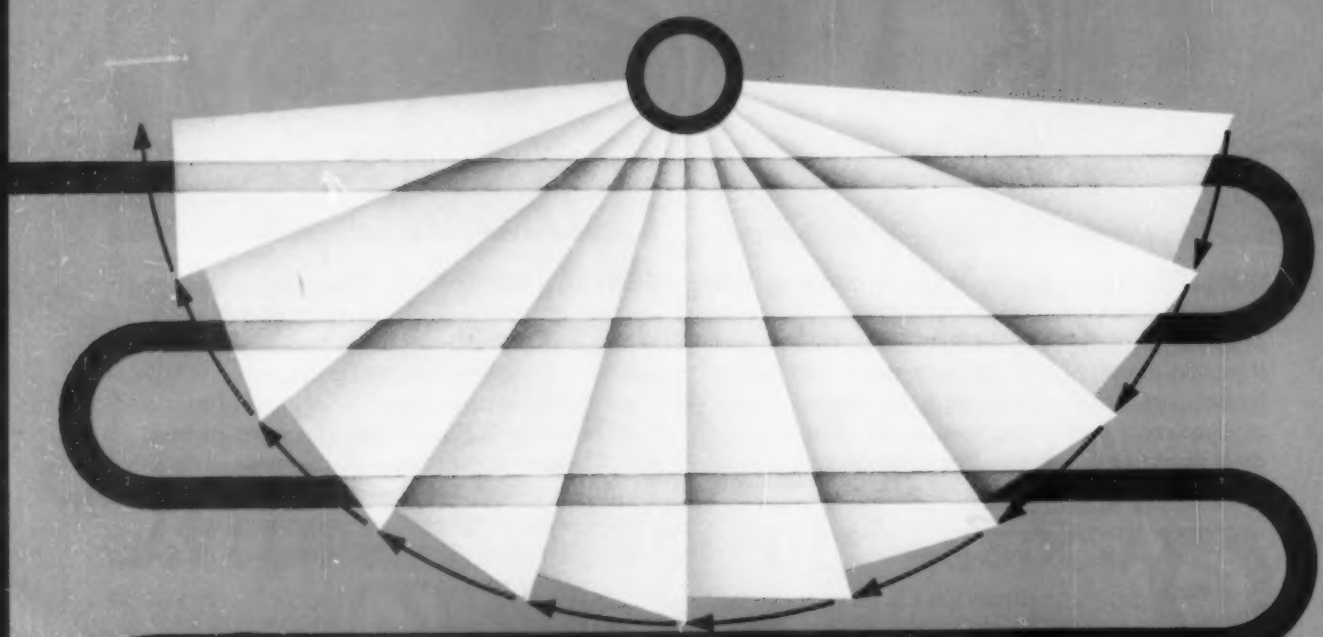
EASTERN GAS AND FUEL ASSOCIATES

For more data circle 506 on Post Card

Diamond developed for more economical power...

AIR PUFF BLOWING=CLEANER BOILERS... AN APPRECIATIVE PUBLIC

THIS.....



Shaded area indicates sustained effective cleaning pattern.

Two of today's more critical conditions for efficient steam generation . . . clean boilers and acceptable stack emission . . . are assured with Diamond Air-Puff Soot Blowing Systems.

Increased cleaning efficiency is obtained because high density air is used as the cleaning medium and emitted in sustained high pressure puffs that are independent of receiver capacity or compressor size. Also, because no air is emitted at ineffective low pressures, there's greater economy in *use* of cleaning medium.

Acceptable stack emission is achieved because intermittent air puff blowing eliminates more concentrated and objectionable emission caused by continuous blowing arcs or blowing puffs of longer duration. In the standard Diamond Air-Puff System, intervals between air puffs are determined by the time required for build-up to optimum blowing pressure; however, if more positive control of stack emission is desired, intervals can be regulated by a simple valve adjustment.

The Diamond Air-Puff Blowing System for new *or* existing boilers of any type and capacity is further evidence of why "Diamond developed" means more economical power. Our engineers will be happy to discuss its application to your units. Call, write or wire for complete information . . . and thank you for reading our advertisement.

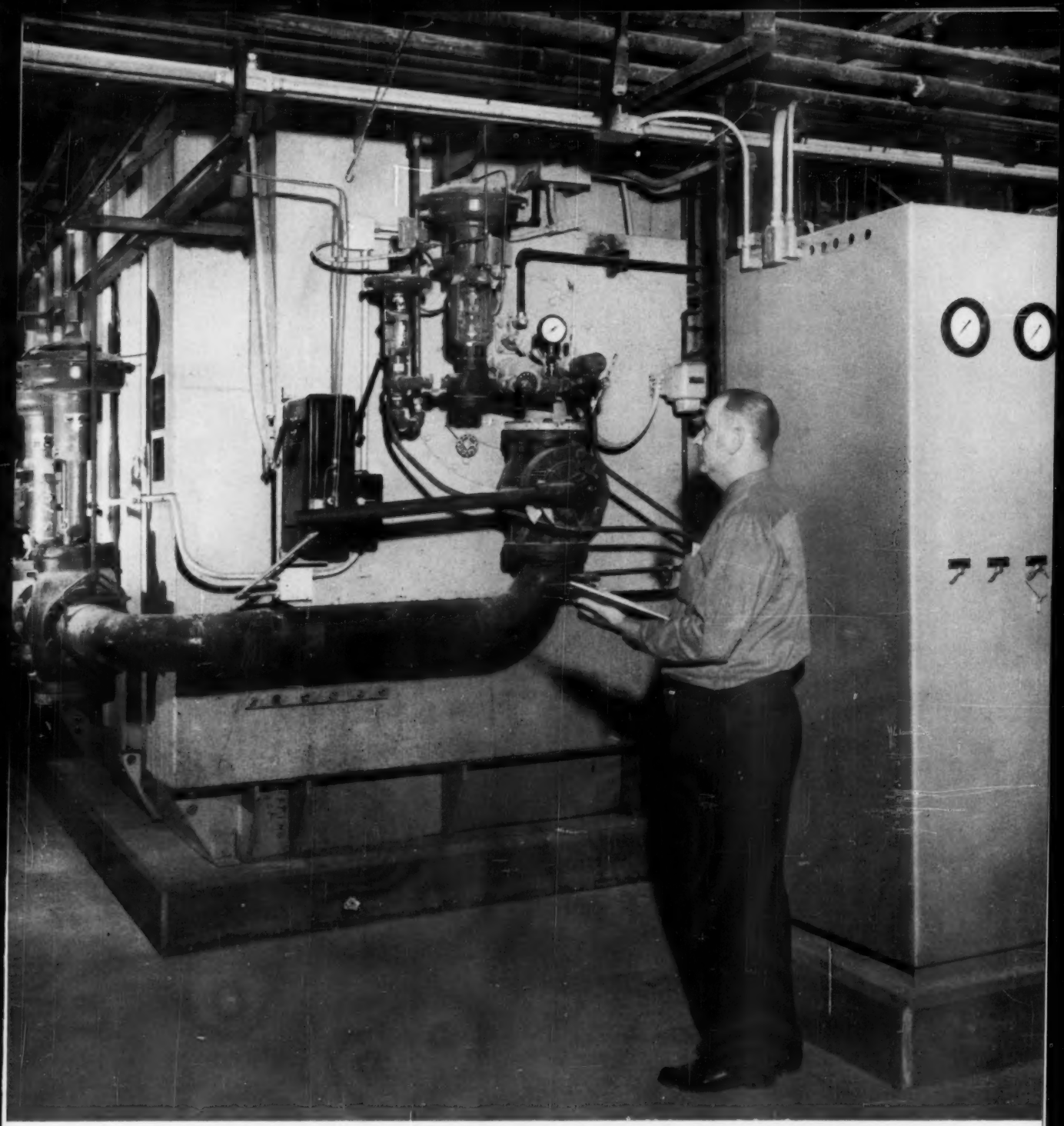
DIAMOND POWER

This is the new trademark of Diamond Power . . . a symbol of quality, integrity and progress . . . in products, systems and service.

DIAMOND POWER SPECIALTY CORPORATION, Lancaster, Ohio
DIAMOND SPECIALTY LIMITED, Windsor, Ontario

ONE THOUSANDTH "FM" SERIES BOILER
MANUFACTURED BY
THE BABCOCK & WILCOX COMPANY
DEDICATED NOVEMBER 15, 1961
AT CHICAGO, ILLINOIS
THE NEW ST. JOSEPH HOSPITAL
SPONSOR SISTER LOUISE MARIE, D.C. ADMINISTRATOR

Except for this plaque...



it's practically the same as 999 other B&W FM boilers.

The 1000th Babcock & Wilcox FM type boiler is now operating. It generates 20,000 lbs steam per hour at 250 psi and 353 F.

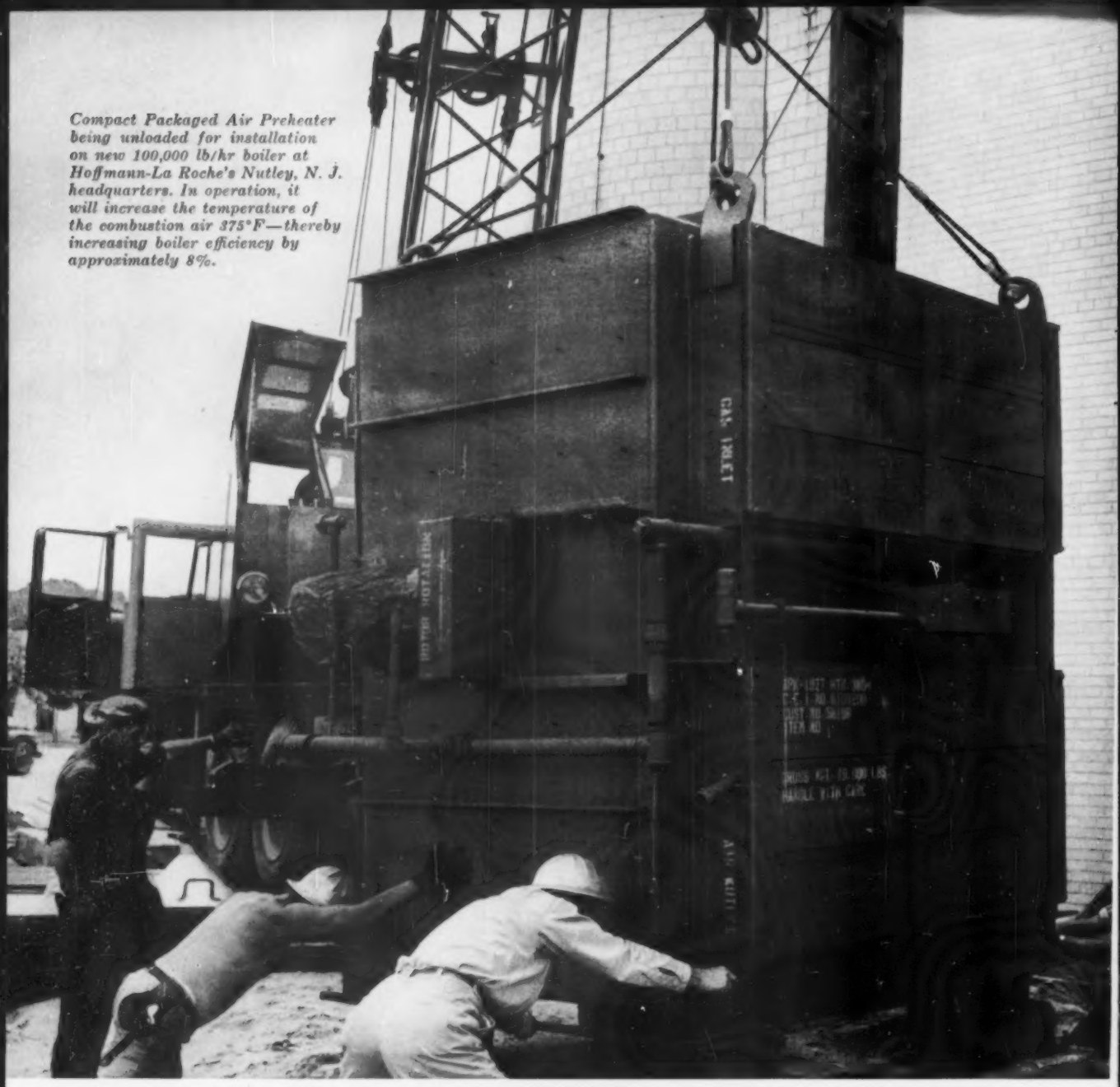
The FM is the most widely accepted and successful package boiler ever developed. In the eleven years since its introduction, the unit has produced heating and process steam economically and dependably in a great variety of installations.

The FM is a shop-assembled Integral Furnace Package Boiler available in capacities of 5,000 to 60,000 lb steam per hour, with pressures to 725 psi and temperatures to 750 F. The FM has automatically controlled oil or gas firing and is simple, safe and easy to operate.

When you need a boiler of assured dependability in the FM size range, contact your nearest B&W sales office or The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

Babcock & Wilcox

For more data circle 508 on Post Card



Compact Packaged Air Preheater being unloaded for installation on new 100,000 lb/hr boiler at Hoffmann-La Roche's Nutley, N. J. headquarters. In operation, it will increase the temperature of the combustion air 375°F—thereby increasing boiler efficiency by approximately 8%.

PACKAGED AIR PREHEATER

WILL RECOVER 330°F FROM NEW BOILER FOR HOFFMANN-LA ROCHE INCORPORATED

Hoffmann-La Roche, one of the leading producers of pharmaceuticals, vitamins and aromatic chemicals, specified a Ljungstrom Packaged Air Preheater for their new boiler for three reasons: 1) This compact, preassembled unit is ready to run as soon as it's connected to the power line and ducts—no extra installation or erection costs; 2) The unit occupies only about 450 cubic feet of space but will cut boiler exhaust temperatures from 680°F to 330°F—for about 8% saving in fuel; 3) Savings in fuel alone—roughly 1% for every 40°F drop in exit gas temperature—can pay for the unit in two short years!

Packaged Ljungstroms are available in sizes for use on boilers in the 25,000 to 250,000 lb/hr range—can give you these same fuel saving advantages. For full information, write today for our 14-page Packaged Air Preheater booklet.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

For more data circle 509 on Post Card

Protect steel stacks with corrosion-resistant concrete

Corrosion-resistant concrete linings, made with LUMNITE calcium-aluminate cement and suitable aggregate, will protect stacks and breechings from the corrosive action of condensate.

When expanded shale aggregate is used, these linings also provide vital insulation. This keeps stack gases hot and helps maintain better draft for greater operating efficiency. The steel shell will stay cooler, too, extending the life of exterior paint. And these monolithic concrete linings have a lower unit weight, which reduces the dead load on the supporting structure.

Whether gunited or plastered, installation is easy and economical, with concrete reaching service strength in 24 hours. For even greater convenience, manufacturers of refractories offer castables bonded with LUMNITE cement – packaged mixtures ready for use with just the addition of water.

For more information, write Universal Atlas Cement, 100 Park Avenue, New York 17, N. Y.

"USS," "Atlas" and "Lumnite" are registered trademarks L-197

INSTALLATION: Elrama Station, Duquesne Light Company, Pittsburgh, Pa.

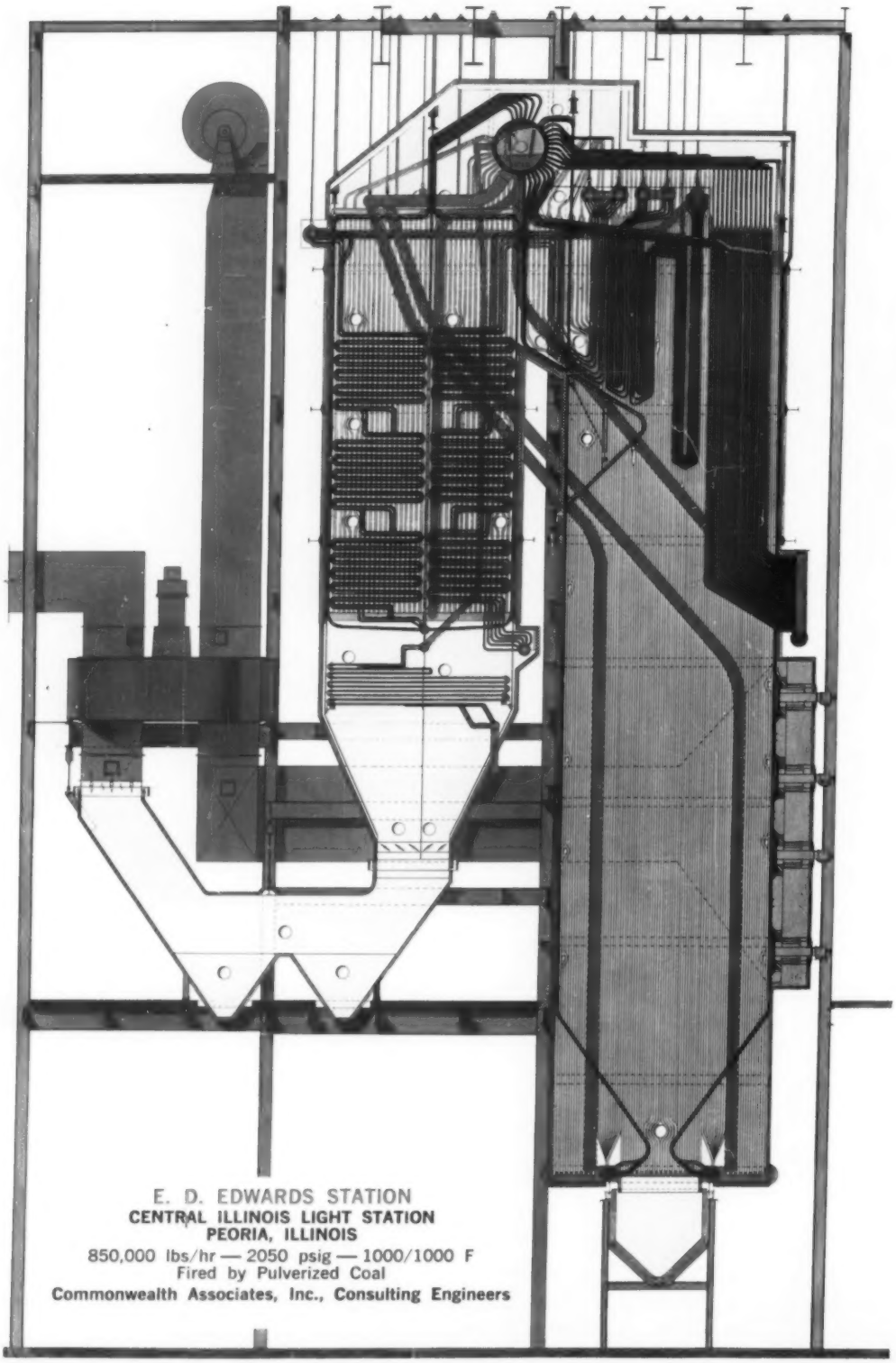
Universal Atlas Cement
Division of
United States Steel

Offices: Albany • Birmingham • Boston • Chicago • Dayton • Kansas City • Milwaukee • Minneapolis • New York • Philadelphia • Pittsburgh • St Louis • Waco

For more data circle 510 on Post Card

Central Illinois Light Company has

850,000 lb/hr Boiler at

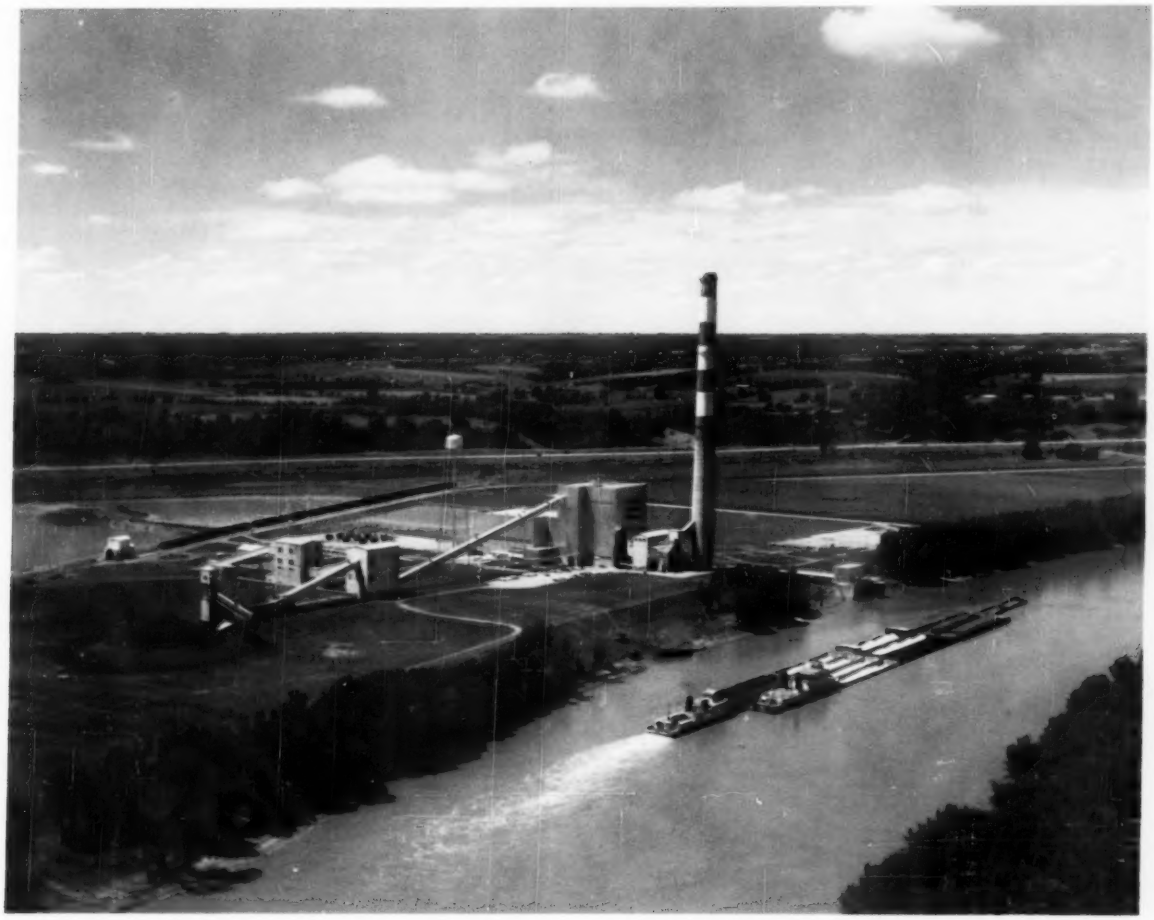


E. D. EDWARDS STATION
CENTRAL ILLINOIS LIGHT STATION
PEORIA, ILLINOIS
850,000 lbs/hr — 2050 psig — 1000/1000 F
Fired by Pulverized Coal
Commonwealth Associates, Inc., Consulting Engineers

A careful survey of your plant by a qualified consulting engineer could show ways of making substantial savings in power costs.

another good RILEY *performer*

E. D. EDWARDS STATION



Central Illinois Light Company has purchased Riley Steam Generating Equipment since 1938. The latest, this 850,000 lb/hr reheat boiler, brings CILCO's total steam capacity with Riley boilers to 3,415,000 lb/hr. Six Riley boilers in operation at CILCO's R. S. Wallace Station at East Peoria, Illinois are continuing to provide dependable operation with records of high availability.

The new Riley boiler at the E. D. Edwards Station, which started operation in April, 1960, is living up to the reputation established by its predecessors.

Reheat steam temperature is controlled by gas flow dampers located below economizer; superheat is controlled by spray. Water tube platens in furnace add to furnace cooling and produce uniform furnace exit temperatures.

Central Illinois Light Company is one of many investor owned electric utilities that have repeatedly purchased Riley equipment. Today, many electric utility customers are installing Riley equipment because they recognize Riley's progressive design of boilers tailored to the requirements of the Electric Power Industry.

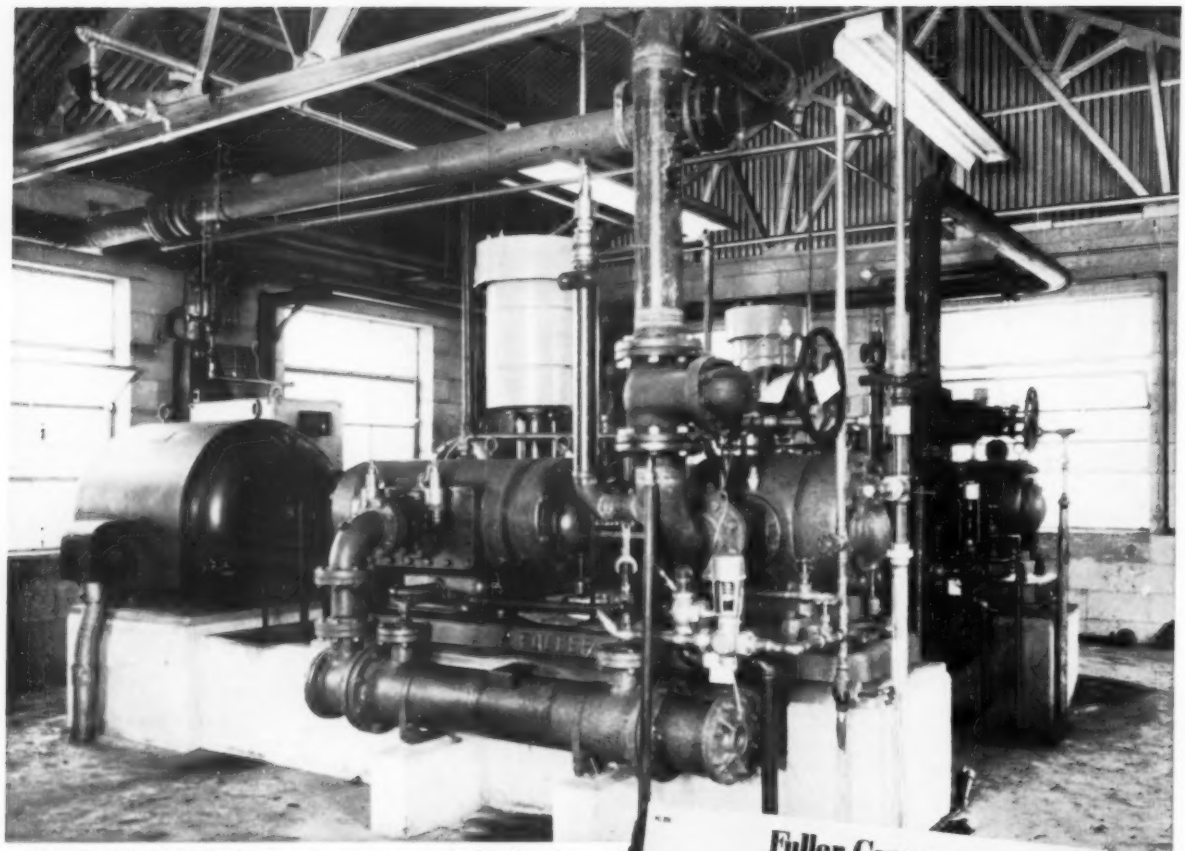
Investigate Riley's newest boiler designs. Call your local Riley representative or write RILEY STOKER CORPORATION, WORCESTER, MASSACHUSETTS.

SALES OFFICES

Boston, Charlotte, Chicago, Cincinnati, Cleveland, Denver, Detroit, Honolulu, Houston, Jacksonville, Kansas City, Los Angeles, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Salt Lake City, San Francisco, St. Louis, St. Paul, Seattle, Syracuse.

RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT



Two C135/135H Fuller Rotary Compressors at the Herbrand Division of the Bingham-Herbrand Corp., Fremont, Ohio, leading manufacturer of forged mechanics' hand tools and steel forgings for the automotive industry. Each compressor is rated 680 cfm, atmosphere to 100/110 psig., at 690 RPM.

Here's the 4-Year Maintenance Bill on Fuller Rotary Compressor at Herbrand Division of Bingham-Herbrand Corp.

So satisfactory was the performance of its first Fuller Rotary Compressor, installed in 1956, that Herbrand Division installed another like it 3½ years later.

When the older unit was inspected after four years operation, no replacement of parts was necessary. After installation of a new gasket (cost $9.35)—to replace the one that had to be removed to make inspection—the compressor continues to add to its service record.

The newer compressor has also been entirely trouble-free, and Herbrand plans a third, when increased air capacity is required. It, too, will be a Fuller—for, as Herbrand says, "These compressors can be classified as maintenance-free."

Because Fuller Rotary Compressors are practically vibration-free, they can be installed without complicated or expensive foundations or structural modifications. They are simple and efficient, with no valves to leak, no seats to grind. Blades automatically compensate for wear. They have forced-feed lubrication to all parts within the cylinder. Rotor, bearings and blades are the only moving parts.

Fuller Compressors range from 30 to 3300 cfm, pressures to 125-lb. gauge.

Write for Bulletin C-5A. It tells the whole story.

See Chemical Engineering Catalog for further details and specifications.

FULLER COMPANY GENERAL AMERICA TRADE MARK

FULLER COMPANY
150 Bridge St., Catasauqua, Pa.
Subsidiary of General American Transportation Corporation
Offices in Principal Cities Throughout the World

Fuller
....pioneers in harnessing AIR

2852
C-364

For more data circle 512 on Post Card

Power plant stretches diesel service -cuts maintenance costs- with AMERICAN D&G Oil No. 53

By C. F. KLENNER Carl Klenner is a specialist at helping customers with their lubrication problems. A graduate of the Michigan College of Mining and Technology, he has been serving commercial customers since 1948. He also attended the Company's Sales Engineering School.

★ ★ ★

At Roseau, Minnesota, the Municipal Power Plant uses Fairbanks Morse Diesel Engines for the generation of the city's electricity. And since 1946, lubricating oils supplied by our Company have played an important part in the excellent maintenance of this plant.

For example, diesel unit number two was overhauled in 1954 after six years' service. At our recommendation, AMERICAN D&G Oil No. 53 was put in the crankcase at that time. After 19,000 hours of oil service, the unit was taken down again. All rings were free, bearings and rings showed minimum wear, and there was negligible carbon on the piston skirts. With AMERICAN D&G Oil, this unit has averaged 4,584 horsepower-hours per gallon of oil.

For additional information about AMERICAN D&G Oil, contact your nearby American Oil Office.

American's C. F. Klenner checks performance reports with power plant superintendent Carl Grand.

Quick facts about
AMERICAN D&G Oil

- Made from highest quality solvent-refined stock.
- Contains additives which impart superior detergent-dispersant and anti-corrosion properties.
- Anti-foaming.
- Oxidation resistant.
- Recommended for
  —use with economy fuels.
  —extreme load service.
  —low temperature service.

AMERICAN OIL COMPANY
910 S. Michigan Ave., Chicago 80, Ill.

AMERICAN

Rockwell-Edward Nuclear

Shippingport, Pennsylvania, 1961: After more than three years of operation, it is possible to report in depth on the manufacture and performance of Rockwell-Edward high-pressure steel valves built for Shippingport, pioneer nuclear power generating station. This report deals with two areas:

1. *How Rockwell-Edward quality control met rigid Shippingport requirements.*
2. *How relatively standard design Edward valves have performed in Shippingport nuclear service since startup in 1957.*

Quality Control

Quality control of the highest order in building steel nuclear valves for the Duquesne Light Company-operated Shippingport Station brought the valve maker's art to new heights. These valves, for the primary coolant system in the first full-scale nuclear power generating station, were furnished by Edward Valves in 1-inch to 18-inch sizes. Since no valves had ever been called upon to perform in such service before and since slightest valve failure could have consequences far more serious than any possible before, Edward was called upon to apply every conceivable technique of quality control known.

From the very beginning, physical and chemical analysis of all component materials was made on every lot and every heat. Statistical lot testing was not adequate.

Testing and Measurement

Normal valve making requires only that certain diameters and angles be watched to critical tolerances. But for the Shippingport valves, every dimension that could be measured was measured and checked to tolerances of thousandths of an inch. All forged steel valve bodies were ultrasonically tested to pick out body flaws that could lead to leaks or stress concentrations. Ultrasonic testing is not ordinarily warranted for valves as small as 1-inch size. After Stellite inlays were laid and machined for seating surfaces, dye penetrants were used to detect porosity, surface flaws, holes and crevices.

All internal surfaces were inspected with a Boroscope. Roughness was held to 30 microinches.

Precision and Cleanliness

Though lapping is usually reserved for valves destined for gas service, the Shippingport valve seats were hand lapped to a maximum roughness of 16 to 30 microinches, rms. All internal surfaces exposed to fluid were polished to 125 microinches, rms. Such fine internal finishing is very difficult on small valves, but had to be done. All internal surfaces were inspected with Boroscopes.

All cleaning and degreasing as well as final assembly were done in the "clean room". All personnel wore lint-free coveralls. No smoking was permitted.

Final Tests

Two-hour hydrostatic tests, back seat tests, and packing tests were done in the "clean room," also. After tests, the completed valves were again oven dried in nitrogen and inspected with a Boroscope for cleanliness, porosity and surface finish. These inspections were made by Edward and representatives of Westinghouse Electric Corp. and the United States Navy. Valves were sealed in polyethylene bags and then removed from the "clean room" for packing according to military standards.

Experience with rigid quality control conditions such as these is hardly routine. But it illustrates what a valve maker can do with his standard line.

Performance Record

Not a single complaint has been received on any of the more than 100 Edward one-inch and two-inch forged steel globe stop valves used in the high-pressure primary reactor system, or on the four 18-inch tilting disk check valves used in the primary coolant pump discharge lines.

A few of the globe stop valves have required routine seat maintenance, but no more than would be expected. Leakage through the packing of the globe stop valves has been consistently within expected limits . . . that

Valve Report:

is, so minute as to be of no consequence. In fact, although many of the Edward globe stop valves were furnished with weldable caps as a precaution against packing leakage, the caps have been welded into place only on those valves in relatively inaccessible areas near the reactor.

Forged steel valves for Shippingport—and for the Westinghouse Belgian reactor and other nuclear projects—were individually sealed in plastic bags.

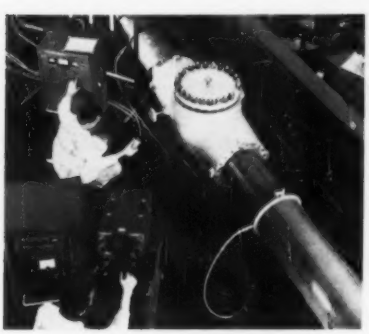
In furnishing high-pressure steel valves for virtually every U.S. nuclear power plant built to date, Edward has demonstrated that excellence of design and manufacture is *the* important ingredient in nuclear power valving, just as it has been in conventional power valving for more than fifty years. They have proved that there *are* important differences in various steel valve lines . . . and that Edward customers get the benefit of these differences.

Edward builds a complete line of forged and cast steel valves from ¼" to 24" for power, industrial, marine, and petroleum services. For more information, contact your Edward Representative, or write Edward Valves, Inc., 1202 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal.

This valve is typical of smaller capped forged steel stop valves furnished for Shippingport. Cap has been screwed into position on bonnet but has not been seal-welded.

Big Cast Steel Valves, Too

The development of suitable check valves for pump discharge service in primary coolant loops of large pressurized water reactors has been substantially advanced by exhaustive flow testing begun in the Edward research laboratories in the 1940's. Equipped with a flow test loop circulating up to 2,000,000 lb/hr of water and capable of flow reversal in a fraction of a second, Edward research engineers have been able to simulate actual service conditions and develop check valve designs with superior opening and flowing characteristics together with the best possible non-slam features upon flow reversal. Full size prototypes of Shippingport, N. S. Savannah, Enrico Fermi, and Indian Point primary loop check valves were tested with this equipment.



6104

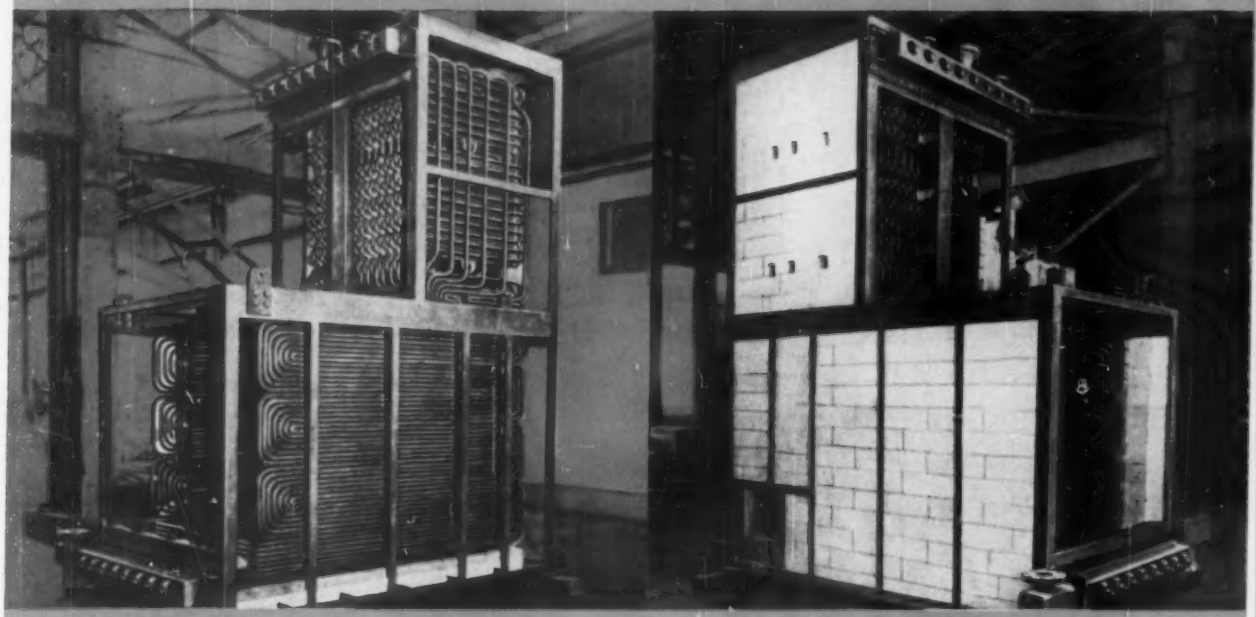
Large 18-inch cast steel stainless steel check valves for Shippingport (left) received same meticulous attention as small forged valves . . . and have functioned with equal dependability since going into service in late 1957.

Other large Rockwell-Edward stainless steel valves were built for primary coolant systems of Babcock & Wilcox N.S. Savannah (center) and Indian Point (right) reactors.

EDWARD STEEL VALVES
another fine product by
ROCKWELL

For more data circle 514 on Post Card

for space heating... or process heat... investigate the ECONOMY and EFFICIENCY of C-E HIGH TEMPERATURE



1 Shop assembly of 12-million Btu C-E High Temperature Water Boiler. Shows steel frame and pressure parts.

2 Same unit with refractory insulation added.

Because the C-E High Temperature Water Boiler makes more heat available than does a steam boiler operating at the same pressure . . . because it allows closer temperature control . . . does not require steam traps or elaborate feedwater treatment . . . has no blow down or condensate losses . . . it is finding ever-wider use in large space heating and industrial processing operations.

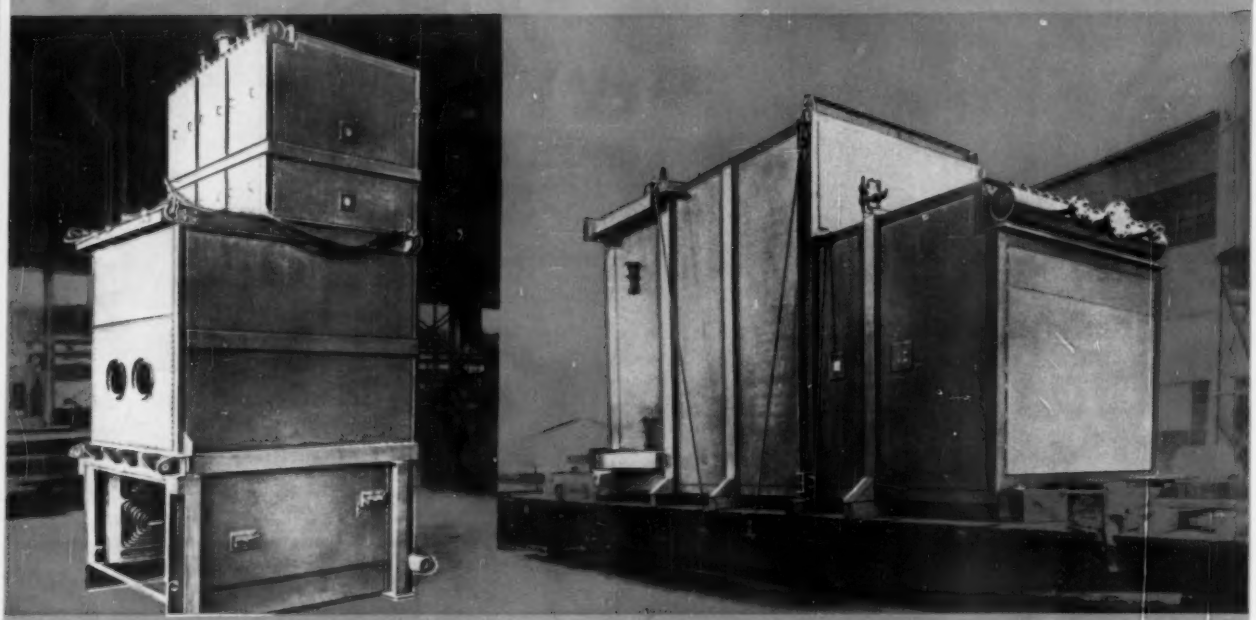
Designed around the same controlled circulation principle used by C-E in many of the world's largest boilers, the C-E High Temperature Water Boiler (Type HCC) operates with low pressure loss. It offers complete control of system and boiler circulation and allows more efficient arrangement of heating surface. It is available for oil, gas, coal or combination firing.

Designed in a wide range of capacities – from 10 million to 300 million Btu's – these boilers operate at water pressures up to 500 psi and temperatures to 470F, or higher. Depending upon local conditions, a C-E Hot Water Boiler can save from 10 to 20 per cent in maintenance and operating costs.

The smaller capacity Hot Water Boilers are completely shop assembled, while the intermediate and large units are shipped in varying stages of assembly.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;

WATER BOILERS



3 A 25-million Btu unit completed with welded casing, ready for shipment. Cables are attached to lifting lugs.

4 Compact, completely shop-assembled units from 20 to 35-million Btu are shipped this way.

This C-E practice greatly reduces erection costs.

So, if you are in the market for boilers, either for space heating or process requirements, it may prove to your advantage to investigate the use of high temperature water as your heat source. Because individual needs vary, both steam and hot water have their place. Our engineers will be pleased to discuss either method with you or your consultants — impartially and with no obligation.

For further details on high temperature water boilers by C-E write for our catalog HCC-2.

COMBUSTION ENGINEERING

C-306

General Offices: Windsor, Conn.
New York Offices: 200 Madison Avenue, New York 16, N. Y.
Canada: Combustion Engineering-Superheater, Ltd.

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

For more data circle 515 on Post Card

why over

◀ *Flanged connection, Yarway Seatless Blow-Off Valve, angle design.*

▲ *Yarway Seatless Blow-Off Valve in open position. Note full, free discharge.*

▼ *Valve in closed position. Note tight shut-off.*

16,000 engineers choose and use YARWAY SEATLESS boiler blow-off valves

■ SAVING IN MAINTENANCE COSTS
■ FREEDOM FROM BOILER OUTAGES

These are the reasons—proved again and again by engineers who know *performance*, in thousands of installations over the last 50 years. Yes, these are the reasons why *Yarway Seatless* has become virtually the "standard" on all low to medium pressure boilers today!

Check these features that are responsible for the acceptance of these time-honored but truly modern, compact valves:

■ **UNIQUE SEATLESS DESIGN** — full, free discharge . . . combined with drop-tight shutoff . . . and no seat to score, wear, clog or leak.

■ **BALANCED HOLLOW SLIDING PLUNGER** —made of nitralloy with a "glass hard" surface that resists erosion, high temperatures and sudden shocks. "Polishing" action lengthens life of packing rings.

■ **COMPRESSION YOKE SPRINGS** — heavy coil springs under yoke nuts maintain continuous pressure on reinforced packing above and below valve port to keep valve tight.

■ **BALL BEARING HANDWHEEL**—for smooth operation, easy opening and closing.

■ **NON-RISING STEM.** Valve cannot be opened or closed too quickly. Water hammer is prevented.

■ **STREAMLINED BODY AND YOKE.** Strength where strength is needed—without unnecessary bulk. "Compact" over-all design.

■ **CHOICE OF FIVE SIZES—1″ to 2½″,** angle or straightway designs, flanged or screwed ends, available in any tandem combination.

If you are planning purchase of a new boiler, or modernization of present boilers in pressure ranges up to 415 psi, *insist* on protecting your investment with new Yarway Seatless Blow-Off Valves.

They'll give you maximum dependability, minimum maintenance, and satisfaction that is beyond price—all at a very *low* cost per year.

Write for Yarway Bulletin B-427.

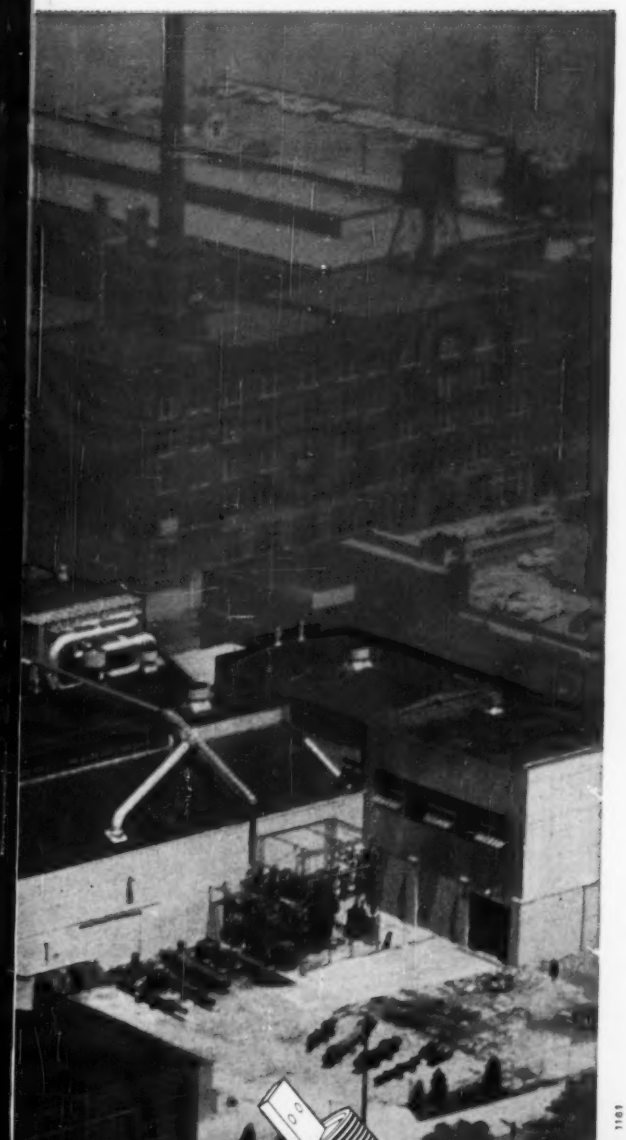
YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY
A MARK OF QUALITY IN STEAM ENGINEERING

For more data circle 516 on Post Card

Electrical Protection goes MODERN with BUSS Fuses . . .

at Sandusky Foundry & Machine Co.
Sandusky, Ohio



THIS ALL FUSE INSTALLATION PROVIDES NEEDED HIGH INTERRUPTING CAPACITY—AND SAVED AN ESTIMATED $20,000

A new electrical system was installed at the Sandusky Foundry and Machine Co., to feed a 1000 KVA annealing furnace and plant feeders and sub-feeders.

The engineers at Universal Marine Construction Co., Sandusky, Ohio who designed and installed the job, estimated the available fault current would be in the neighborhood of 75,000 amperes.

To be sure of obtaining the needed safe and dependable protection BUSS Hi-Cap and FUSETRON dual-element fuses were installed.

DEPENDABLE PROTECTION AT A $20,000 SAVING

Including the cost of fuses and switches, an estimated $20,000 was saved over what it would have cost to use mechanically operated devices with an interrupting rating of only 75,000 amperes.

This BUSS and FUSETRON fuse installation also permitted the electrical system to be co-ordinated, so outages on feeder and sub-feeder circuits can be limited to the circuit on which trouble occurs.

ELECTRICAL SYSTEM NOT DISTURBED WHEN TRANSFORMER CAPACITY WAS INCREASED

Shortly after the original installation, additional transformer capacity was added,—bringing the available fault current to approximately 150,000 amperes.

No change in the main service panels was needed, however, as the 200,000 amp. interrupting capacity of BUSS Hi-Cap fuses is still adequate to assure safe protection.

Neither was a change required in the protection of feeder circuits because FUSETRON fuses have adequate interrupting capacity to safely handle any fault that might occur on them.

SAFE PROTECTION REMAINS SAFE

After years of inactivity, BUSS Hi-Cap and FUSETRON fuses provide the same safe, accurate protection if called upon to open as they would on the day installed. Dust, fumes, corrosion or age cannot increase the capacity of fuses or lengthen their blowing time.

For more information on how to select the proper fuse, write for the new BUSS booklet . . . *Basic Protection for Electrical Power Systems.*

BUSSMANN MFG. DIVISION, *McGraw-Edison Co.,* **ST. LOUIS 7, MO.**

1161

BUSS
FUSE
FUSETRON
FRN 200
6-1200 amp. switches with 1200, 800, and 650 amp. Buss Hi-Cap fuses.
1-3000 amp. switches with 3000 amp. Buss Hi-Cap fuses.
100, 200 and 400 amp. switches with FUSETRON dual-element fuses for feeder and sub-feeder protection.
KEEP ELECTRICAL
with Safety!

For more data circle 517 on Post Card

RODA COKE — High carbon — low sulphur — low phos. Unmatched for reduction purposes.

GENERAL

GENCO ANTHRACITE & BITUMINOUS COALS

•

WESTMORELAND COAL COMPANY

•

STONEGA COKE AND COAL COMPANY

•

JEDDO-HIGHLAND COAL COMPANY

Coals differ in their characteristics — that's why General strives to make sure you get the proper coal for your particular application. We endeavor to insure that every car of coal we ship meets the specific need for which it is intended.

GENERAL COAL COMPANY

123 SOUTH BROAD ST., PHILA. 9, PA.

Cable Address: Phila. GENCO; New York, GENCOAL
Branches: Buffalo, N. Y.; Charlotte, N. C.; Cincinnati, Cleveland, Ohio; New York, N. Y.; Norfolk, Va.

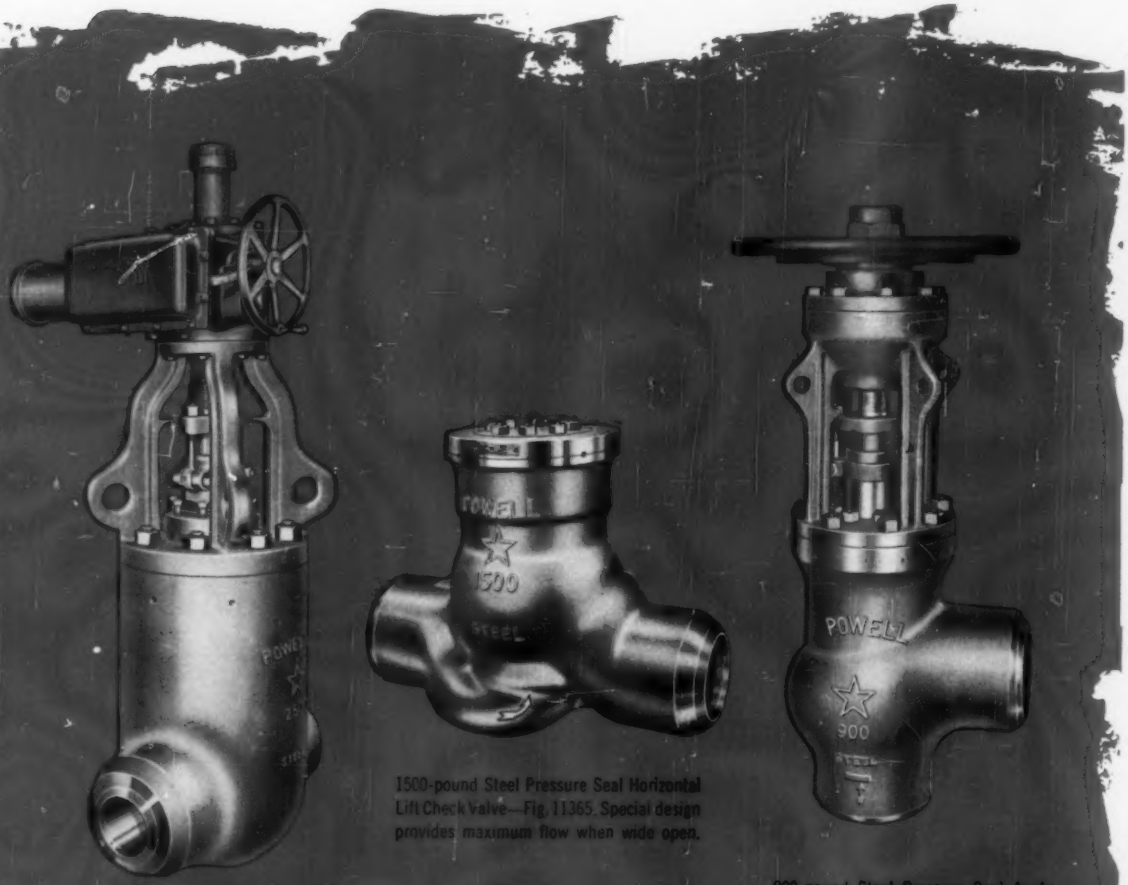
For more data circle 518 on Post Card

POWELL MAKES IT A SIMPLE MATTER

To find the right valve for power plant installation, just call Powell. It's that simple, since Powell can supply just about any type of valve you may need to control water, oil, gas, air, steam or corrosive fluids.

What's more, you don't have to wonder about Powell performance. It's built-in through sound engineering, development, materials and workmanship . . . and proved day in, day out.

So, remember, finding the right valve can be a simple matter when you specify Powell. For further information, call your nearby Powell Valve Distributor (there's one in every major city), or write us direct.



2500-pound Steel Pressure Seal Gate Valve—Fig. 125023. Mounted with electric motor operator for remote control.

1500-pound Steel Pressure Seal Horizontal Lift Check Valve—Fig. 11365. Special design provides maximum flow when wide open.

900-pound Steel Pressure Seal Angle Valve—Fig. 19033. Powell Pressure Seal Valves are available for pressures from 600 pounds through 2500 pounds and higher.

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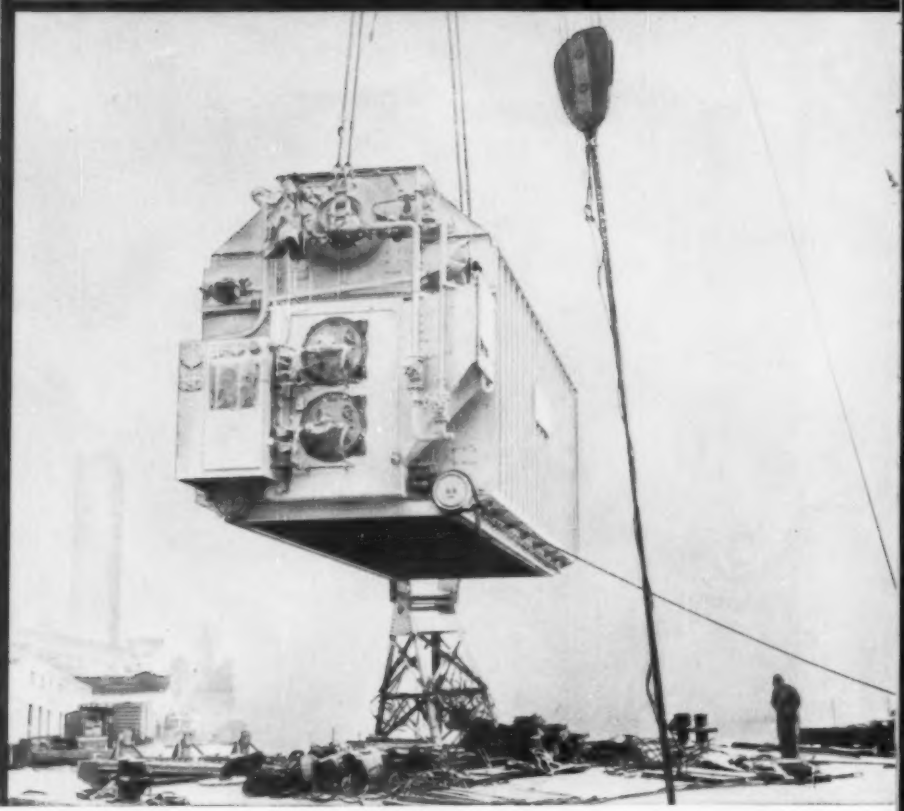

VIA RAIL, BARGE AND TRUCK:

two 100,000 lb/hr steam generators move into heart of New York City

En route to Pennsylvania Station South Housing Project in Manhattan, this pair of Union Type MH Packaged Steam Generators demonstrates how steam requirements (in excess of 100,000 lbs./hr.) can be fulfilled without involving field assembly.

Placed by the contractor, Raisler Corporation, the two units were shipped complete with refractories, casing, MH Firing Units, and connecting duct work. Equipped for burning No. 6 oil, each of the MH's has a capacity of 100,000 lbs./hr. at 450 psi and 600° F.

Shop assembled to standardized designs, Type MH Steam Generators and Firing Units can be supplied to handle diversified needs without costly special engineering. They can be arranged for oil or gas firing or both, with fully automatic, semi-automatic or manual control. The symmetrical, 3-drum MH design, with the top drum centered, makes it possible to ship larger units within existing rail clearances.

For detailed information, contact your local Riley Stoker Corporation or Union Iron Works office.

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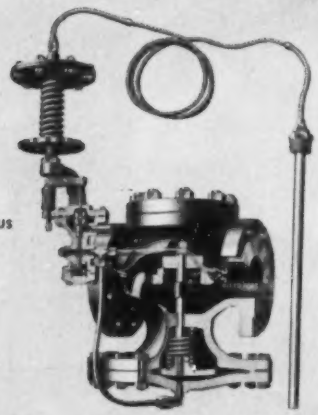
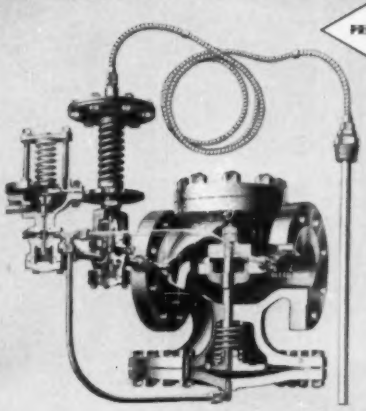
VALVE TIPS:

How to Select Automatic Regulating Valves For Temperature Control

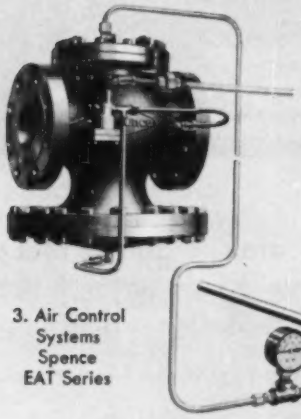
THE MOST COMPLETE LINE OF PRESSURE AND TEMPERATURE REGULATORS IN THE WORLD



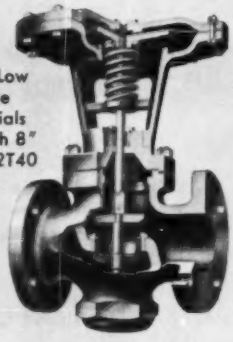
1. Instantaneous Heaters Spence ET124 Series



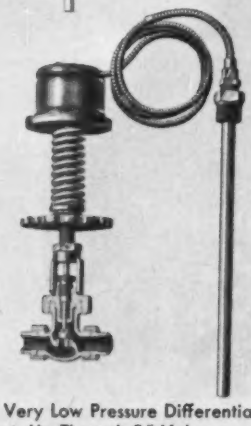
2. Storage Heaters Spence ET14D



3. Air Control Systems Spence EAT Series



4. Very Low Pressure Differentials 2″ Through 8″ Spence G2T40



5. Very Low Pressure Differentials Up Through 2″ Valves Spence Direct Acting T2

During the past year, our field representatives have reported many cases of improperly, and uneconomically, applied temperature regulators. To help you avoid some of these costly mistakes, here are a few tips on selecting the most effective and economical temperature regulating valves for your applications.

1. Instantaneous heaters require a special action for close temperature control and freedom from hunting. In the Spence ET124 series, steam pressure is modulated according to temperature (demand) and is automatically regulated at any pressure established by the demand.
2. Storage heaters, on the other hand, are more economically controlled by the Spence ET14D, which includes a simple temperature-actuated pilot that opens and closes the main valve to maintain a constant temperature.
3. Air control systems can now have a ±5°F control accuracy under wide and instantaneous load swings with the Spence EAT regulator. Engineers report savings of up to 50% in installed costs with this recently developed Spence cascade system when it has been used in place of conventional instrumentation.
4. For the combination of very low pressure differentials and air or water control, Spence recommends Type G2T40. This single seated pilot operated valve provides fast, positive response in 2″ through 8″ valves. Double seat Type G22 is also available in 10″ through 12″.
5. When very low pressure differential is encountered with valves of 2″ or less, the Spence direct operated T2 is recommended. The sensitive vapor tension thermostat responds quickly to small changes in bulb temperature for continuous, accurate control.

In this brief description of industrial process and heating temperature control, we have given a few important tips in proper regulator selection. If you would like more detailed information on these control applications, write for the new Spence Temperature Control Bulletin IV 1014. 88-180

SPENCE ENGINEERING COMPANY, INC.
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stoker advantages

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Detroit RotoGrate Stoker with two of the six Rotors removed to show the overlapping highly restricted grate designed especially for spreader stoker firing.

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Current Catalogs

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Post Cards provided on pages 89 and 90.

Valves, Piping, Fittings

101 New Idea in Ball Valves—Bulletin PB911, by General Kinetics Corp., describes a new design in Ludeman Rotoflo valves for critical applications involving high pressure and temperature, and radio-active environments. Specifications are included and operation illustrated.

102 Low Maintenance Ball Valves—Information on manually operated and pneumatically operated ball valves is presented by Hills-McCanna Co., in 32-pp Catalog 1200-A. Pneumatic operators for automatic and remote on-off operation are illustrated, also special valves, and dimensions given.

103 Valve Sizing — This technical paper by Jordan Valve Div., Richards Industries, Inc. explains dangers of oversizing, undersizing of valves for pressure reducing applications. Covers advantages of using sizing chart.

104 Bonnetless Valve—Bulletin 302, 8 pp, by DeZurik Corp., describes a rubber-seated bonnetless knife gate valve. Features, materials and dimensions and applications outlined.

105 Three-Way Vacuum Valve — Details on a three-way valve that offers minimum restriction to gas flow and replaces doughing, foreline and conventional high vacuum valves are described in 8-pp Booklet 328 by Central Scientific Co. Mechanical specifications, installation, operaton, maintenance, parts replacement covered.

106 Solenoid Valve Developments—Included in this 16-pp supplement by Automatic Switch Co. are catalog sheets on two-, three- and four-way solenoid valves developed since issuance of the last general catalog. Gives maximum pressure ratings, operation details, dimensional data and diagrams.

107 Pipe Fitting Data Sheet—Dimensions of short radius, extra-strong 90-deg elbows and 180-deg returns are charted in Bulletin TF-511, by The Babcock & Wilcox Co.

108 Seamless Welded Fittings — Featured in Bulletin TF-510 by The Babcock & Wilcox Co. are 90-deg elbows, long tangent one end or both ends, standard weight and extra strong. Includes charts on pertinent dimensions in nominal pipe size 1½ through 12 in.

109 Spring-Actuated Hangers—Counterpoise and Levelglide pipe hangers are described in 16-pp Bulletin 157, by National Valve & Mfg. Co. Travel-load capacities are charted and physical dimensions are shown.

Pumps

110 Glassed Centrifugal Pump — Bulletin 725.3, by Goulds Pumps, Inc., describes pump with bonded glass covering surfaces contacting pumpage, making it highly corrosion-resistant. Construction details, dimensions and sectional views included.

111 Proportioning Pumps — Jaeco Pump Co.'s Bulletin 861, 12 pp, describes both standard and Strokontrol proportioning pumps, emphasizing adjustment and other advantages of the Strokontrol design. Capacity and selection tables are included with data for chemical processing industries.

112 Pumps, Control Components — In Bulletin 47740, 20 pp, The Oilgear Co. shows how electrohydraulic servo controlled pumps and system components work, what functions they perform, and where they are applied. Schematic drawings, pictures and specification charts are included.

Mechanical Power Transmission

114 Syncronized-Speed Drives — Bulletin 112 by The Louis Allis Co. describes operation of Syncro-Range Select-A-Spede Drives, with specifications and schematic layout included.

115 Adjustable-Speed Drive — Bulletin A-919, 12 pp, American Radiator & Standard Sanitary Corp., describes application and advantages of "on the shaft" Gyrol fluid drive to boiler feedwater pumps. Cross-section drawings of two designs show how they work, with layout dimensions and selection data included.

116 Chemical Service Units—Application Bulletin 113, by The Louis Allis Co., features gearmotors, adjustable speed drives, and drip-proof and wound rotor motors for use in chemical processing industries, with installation photos, descriptive details.

117 Bearing Guide — Sizes and styles of Life-Lube ball-bearing pillow blocks, flange and take-up units, porous-bronze and babbitted pillow blocks are covered in 12-pp Bulletin 7104 by T. B. Wood's Sons Co. Includes babbitted bearing information on load-ratings and maximum shaft speeds.

Packings, Gaskets

118 Molded Packings—Catalog MP-361, 8 pp, by Greene, Tweed & Co., describes packings for pumps, compressors, and other hydraulic and pneumatic equipment. Tables list compounds in which each packing is furnished for various fluids and temperatures, also recommended types for machinery.

119 Leak-Proof Gaskest — Bulletin PK-152A, 28 pp, by Johns-Manville, describes six basic designs of Goetze metallic gaskets, covering "where recommended," "how they work," "why suggested," and "what constructions are available." Selection charts suggest choices for applications and service conditions and show maximum operating temperatures for standard metals.

Electrical

120 Turbine Pump Motor Guide—This 28-pp handbook of instruction of U. S. Electrical Motors Inc., assists users of Type HU turbine pump motors to obtain optimum operation. Installation, operation, maintenance and repair, with photos, drawings covered.

121 Motor Winding Protection—In 8-pp Bulletin F2034, U. S. Electrical Motors Inc., dscribes tests made on Everseal formulation and solid-cast stators. Photos show protection afforded against fumes, extreme temperatures, water splash, dust and other environmental conditions.

122 Preferred Design Transformers—Twelve-pp Bulletin GEA-6604B covers scope, dimensions, and features of General Electric Co.'s preferred design power transformers rated up to 230 kv, 400,000 kva. Includes details on low-height design, reduced floor space requirements, cooling arrangements.

123 Vacuum Capacitor Switch — Bulletin 71B9754, by Allis-Chalmers Mfg. Co., describes a compact, low cost vacuum switch. Tells the how and why of vacuum switching, how to order these switches. Includes three-phase bank application guide.

124 Stored-Energy Switchgear — Bulletin 2800-2B, 38 pp, by I-T-E

Current Catalogs

Circuit Breaker Co., describes 4.16- and 13.8-kv circuit breakers and switchgear, giving details on stored-energy closing system, face-wound blowout coils and closed-door draw-out. Simplified specification guide lists components for each unit.

125 Meter-Relays — Operating features of locking contact meter-relays, and standard circuits for achieving popular types of control action, are described in Bulletin 5, 24 pp, by Assembly Products, Inc. Includes dimensions, sensitivities, case styles.

126 For Regulated Voltage—Bulletin 61202, 12 pp, by Line Materials Industries, on self-regulating transformers, explains their connection versatility and location flexibility. Operating and design features are described and ordering data listed.

127 Control Cable — How to determine load requirements, selection of proper core size, and design requirements for Push-Pull control cable are covered in Bulletin 162-961 by The Morse Instrument Co.

128 Null Balance Recorders—Single and multi-pen null balance recorders and recorder-controllers are described in 12-pp Bulletin GEA-6887 offered by General Electric Co. Covers typical measurements performed and includes specifications.

129 Dielectric Testing — Eight-pp Bulletin 10-15.1, offered by Associated Research, Inc., contains excerpts from a technical seminar on problems of high potential dielectric testing.

130 Power Supplies—Standard and custom-engineered power supplies, from 50 w to 5,000 kw, are described in this 44-pp catalog by American Rectifier Corp. Provides suggested applications, diagrams, and a glossary of power-supply terms. Basic power supply and control evaluation chart tells what type of power is best for given features.

131 Electrical Tapes—Detailed information on plastic tapes, friction tapes, splicing compounds and special purpose tapes is include in this 8-pp bulletin by Plymouth Rubber Co., Inc. Physical, electrical properties listed.

132 Electronic Products — Catalog 210A, 584 pp, by Allied Electronics Corp., describes electronic parts and products for industry, listing capacitors, relays, plugs, transformers, public adress and communication systems and hundreds of other products. A directory of semiconductors is designed to facilitate ordering and presents transistors, diodes etc. A technical book section lists titles on electronics and related subjects.

Lighting

134 Fixtures and Floodlights — Weatherproof cast aluminum fixtures, floodlights and luminaires are described in Catalog B-62, by Stonco Electric Products Co., with applications, features and dimensions included.

135 Area Lighting Guide—Included in General Electric Co.'s 30-pp Bulletin GEA-7223 are an equipment selector, sample lighting layouts, descriptions of typical area lighting applications, with photos, equipment recommendations. Also covers structural features and electrical characteristics of incandescent, mercury and fluorescent fixtures, as well as specifications for lamps, external ballasts, controls, brackets and poles.

136 Area Lighting Reference—Bulletin GET-3100, 16 pp, by General Electric Co., describes basic functions of luminaires, with photometric data and sample problems for lighting applications. Includes discussion of economic consideration for design selection, with technical standards by which to measure choices.

Lubrication

137 Lubricating Grease — Basic principles and properties of lubricating grease are detailed in a 32-pp summary offered by Bardahl Mfg. Corp., covering types of grease and applications. Effect of additives on grease properties is covered and information on company's multi-purpose lubrication production included.

138 Breaking Lubrication Barriers —Theory and use of solid lubricants are covered in Bulletin 132, 8 pp, by The Alpha-Molykote Corp. discussing barriers to effective lubrication and properties of molybdenum disulfide as a dry-film lubricant. Applications are shown, and graphs, charts and line drawing are included.

Safety

139 Why Furnace Explosions — Causes of furnace explosions are analyzed and recommendations for safe operating procedures are discussed by The Babcock & Wilcox Co. in 16-pp illustrated Bulletin E-101. Safety devices are listed.

140 Combustion Lines Protection—Buletin B-10, 12 pp, by C. M. Kemp Mfg. Co., describes operations and features of Fire Guards for flammable and combustible line protection. Diagrams and charts give specifications.

141 Fire Pump Protection—What to consider in selecting protective equipment is covered in Cutler-Hammer Inc's Pub. LJ25, 8 pp, on fire pump controls. Requirements of underwriter associations and fire insurance companies are listed, and maximum ratings and dimensions are listed.

Instruments and Controls

142 Liquid Level Controls—LevelAc liquid level switches are described in 12-pp Brochure SF-765, by the Fulton Sylphon Div., Robertshaw-Fulton Controls Co. Principles of operation and advantages are covered and selection questionnaire included.

143 Valve Remote Controls—Bulletin 618, 20 pp, Stow Mfg. Co., describes flexible shafting such as valve couplings, remote operating terminals and handwheels, standard rigid reach rod controls; and gear boxes operable in any angle. Selection data covering installation to 27-in. diam handwheels are included in the bulletin.

144 Air Control Regulators—Application engineering data, hook-up diagrams, recommended installation and steam capacity tables are included in Application Guides A5B10 by Spence Engineering Co., Inc. Covers ways to obtain accurate steam pressure control at minimum cost with standard air control regulators.

Postage-free cards for ordering catalogs are on page 89. You may also use the cards to order literature mentioned in the ads.

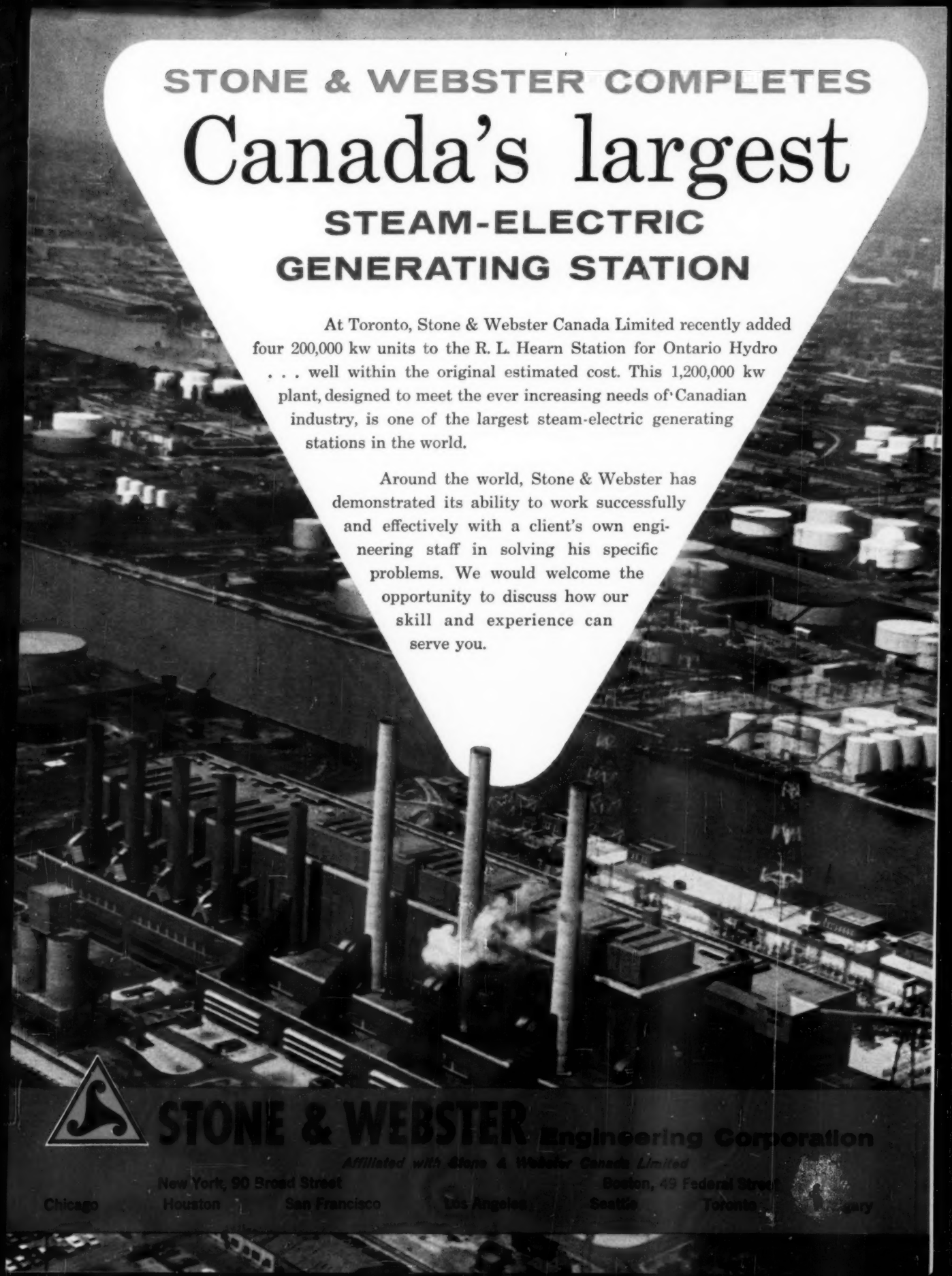
145 Electrical Tachometer System —Complete tachometer systems, including transmitter, receiver and drives and enclosures for wall mounting and waterproof models, are described in Bulletin 720, 10 pp, by Herman H. Sticht Co., Inc. Applications and dimensions and specifications listed.

146 Solid State Recorder—Transistorized high-speed sequential recording annunciator is featured by Panellit Div., Information Systems, Inc. in 8-pp Bulletin 113. Includes details on operational characteristics and summary specifications data sheet.

147 Transistorized Annunciator—A solid state annunciator packaged in interchangeable plug-in modules is described in 12-pp Brochure 200 of Rochester Instrument Systems, Inc. Specifications, operational sequences and a schematic drawing are included.

148 Closed Circuit TV — Bulletin ATVB-100.1, 8 pp, Fairbanks, Morse

more Current Catalogs page 89



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STEAM-ELECTRIC GENERATING STATION

At Toronto, Stone & Webster Canada Limited recently added four 200,000 kw units to the R. L. Hearn Station for Ontario Hydro . . . well within the original estimated cost. This 1,200,000 kw plant, designed to meet the ever increasing needs of Canadian industry, is one of the largest steam-electric generating stations in the world.

Around the world, Stone & Webster has demonstrated its ability to work successfully and effectively with a client's own engineering staff in solving his specific problems. We would welcome the opportunity to discuss how our skill and experience can serve you.

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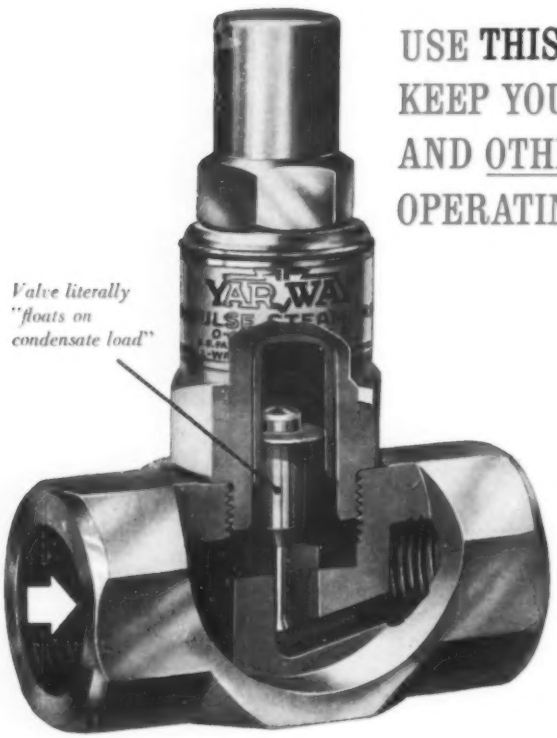
STEAM TRAPS STOCKED AND SOLD BY 270 LOCAL INDUSTRIAL DISTRIBUTORS



Valve literally "floats on condensate load"

USE THIS YARWAY STEAM TRAP TO KEEP YOUR DRYERS, COOKERS, TANK COILS AND OTHER PROCESSING EQUIPMENT OPERATING AT PEAK EFFICIENCY

Yarway Series 60 Impulse Steam Traps are the traps "designed with high production in mind." They get processing equipment hotter, sooner—and keep it hot. Here's how:

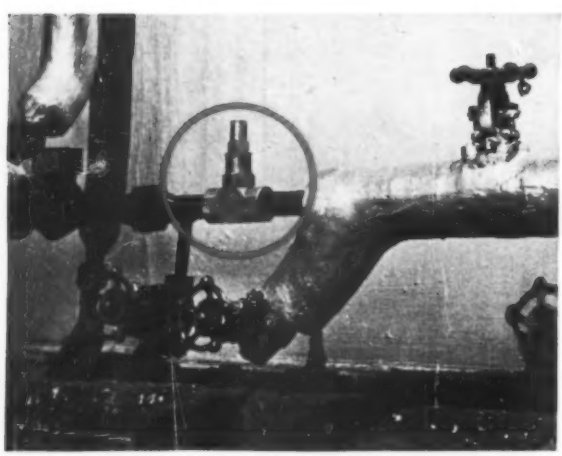
The only moving part, a small stainless steel valve, literally "floats on the condensate load." When equipment is started up, and condensate load is heavy, it opens wide and discharges at full capacity to bring equipment to operating temperature as quickly as possible.

In operation, it continuously senses condensate temperature, discharging each bit of condensate as it forms instead of storing up a bucketful. Result—higher temperatures, more even temperatures, more productive equipment.

Other Yarway features—small size, light weight, good for all pressures, low maintenance, stainless steel.

Yarway pioneered the impulse trap with its unique thermo-dynamic principle over 25 years ago. Most users find among Yarway's full line of impulse traps the profitable and productive solution to their steam trapping problems—you can too!

You can get Yarway's latest steam trap Bulletin T-1743, or a 90-day trial of any Yarway Steam Trap, by writing Yarnall-Waring Company or contacting your local Industrial Distributor.



¾" Yarway Impulse Steam Trap draining tank coils on sulfur storage tank, 175 lbs. pressure

YARWAY OFFERS IMPULSE STEAM TRAPS FOR THESE SPECIFIC OPERATING CONDITIONS

AVERAGE CONDENSATE LOADS	EXTRA HEAVY CONDENSATE LOADS	LIGHT CONDENSATE LOADS
Series 60	Series 40	No. 30

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DEFINING THERMAL POLLUTION

Richard D. Hoak of Mellon Institute discusses the legal and scientific aspects of the problem of discharging heated wastewater to streams

CONSERVATIONISTS have been expressing concern over the present and future effects of discharging heated wastewater to natural streams. Various undesirable results have been cited against raising stream temperatures, but the major emphasis has been directed toward the effects on aquatic life, especially fish. The temperature of water alone can determine the species that can live and reproduce in a body of water. But other temperature-dependent factors, such as toxicity, pH, dissolved oxygen concentration, and the physical activity of fish, are also important in the stream environment. Thus the effects of discharging hot water cannot be neglected where fish propagation is a local desideratum.

Streams and rivers comprise a highly important national resource with many uses. Unfortunately, certain uses conflict with others, while some uses are mutually exclusive. There is universal agreement that the first priority of water use must be assigned to public water supply. But the relative priorities of other uses, such as industrial, navigational, irrigational, recreational, and hydro power, cannot be fixed in any broad sense because of the variation in local interests from area to area.

One significant function of surface streams is to carry away and assimilate the wastewater of civilization. This use of streams is neither improper nor illegal. Indeed, in nearly every case, the public interest demands that the receiving water serve as the final stage of a waste-treatment installation. It is essential, however, that treatment be provided for wastewater to the extent that the discharge will not utilize more than a reasonable fraction of the stream's capacity for self-purification. This is necessary to protect downstream uses.

It is easy to accept the principle of reasonable use of streams for waste disposal because it represents economic logic. But problems arise in applying the principle to specific situations, due to the difficulty of reaching agreement on the reasonableness of a particular use. This difficulty is a direct consequence of our limited quantitative information on the actual effects of most components of industrial wastes on water quality. A good example of the scantiness of our knowledge occurred when the Pennsylvania Department of Health concluded that it would be desirable to control discharges of heated wastewater. It was quickly discovered that very little factual information was available to furnish a basis for drafting suitable regulations!

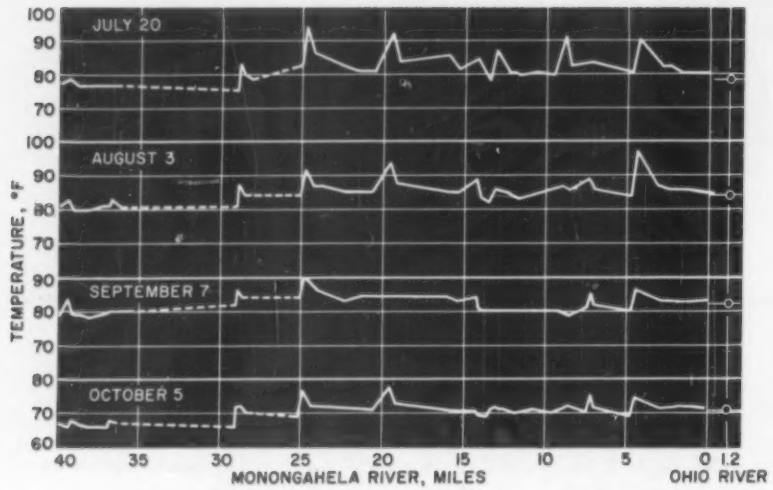
A few states have rules governing heated wastewater. Although these are somewhat indefinite, they appear to be satisfactory for present needs. But the presumed necessity for imposing rather strict controls over stream temperatures derives from predictions of a steady increase in thermal loads. The potential effects of electric power generation are usually referred to in these predictions because of the trend of that industry to double its capacity every decade.

Proposed Regulations

The Pennsylvania Department of Health, in anticipation of the future, proposed a set of regulations to govern heated wastewater. The proposal was advanced to serve as a basis for discussions that would lead to practical temperature controls. The proposal was:

1. Heated discharges to the waters of the Commonwealth shall at no time or at any place raise the temperature of such water above 93 F during the months of May through November, or above 73 F during the months of December through April, nor shall the temperature be raised at all in streams suitable for trout propagation.

2. The increased heat content caused by an industrial or other process in liquid discharges shall be reduced by at least 35 per cent for streams requiring "primary" treatment; by an intermediate degree, to be determined by the circumstances in each case, for streams requiring "intermediate" treatment; and by at least 85 per cent for streams requiring "complete" treatment — except that in no case shall the temperature of any discharge be required to be reduced below the average tempera-



Typical stream temperature data

ture of the receiving stream above such discharge.

3. In order to allow fish and other aquatic life to move freely both up and down stream, a fishway shall be constantly maintained in any stream receiving heated discharges, within which the temperature of the water shall not be raised. The average width of this stretch shall be not less than ¼th that of the average width of the stream in the affected zone, and the flow shall be not less than ¼th that of the receiving stream just above the point of waste discharge. Moreover, this stretch shall extend from above the point of waste discharge to the location at which the stream returns to normal temperatures.

4. Exception to the foregoing may be made for estuarial waters, where currents are variable and uncertain.

5. The proportion of the stream which will be allocated to any given user shall be determined by the Sanitary Water Board based on the present and anticipated future use and condition of the stream or receiving body of water.

These tentative regulations aroused considerable criticism, especially from industry. The Department of Health therefore appointed an advisory committee for control of stream temperatures to study the problem and make appropriate recommendations.

The committee was broadly representative of industry and conservation organizations; five of the nine members were engineers. Subcommittees were appointed from time to time to investigate particular aspects of the problem, and meetings were held with staff members of the Division of Sanitary Engineering about once a month from September 1959 to April 1961.

The committee submitted its report to the Pennsylvania Sanitary Water Board in May 1961, and the substance of its recommendations was promulgated in August 1961 as Section 16 of Article 600 of the Rules and Regulations of the Board.

The following is the author's interpretation of the committee's studies; it is not a committee report.

Temperature Limit

Where fish propagation is a major consideration there is little leeway for choice of a maximum allowable stream temperature. Numerous laboratory studies have fixed lethal maxima for most species of game fish. It is beside the point to argue that these limits often have no relationship to fish survival in natural streams. There are so many variables to cope with in actual streams that limiting values must be determined under carefully controlled laboratory conditions if the results are to approximate universality. On the other hand, it is proper to select limits suitable to specific local conditions where these can be established by field surveys.

The Aquatic Life Advisory Committee of the Ohio River Valley Water Sanitation Commission (ORSANCO) reviewed available laboratory data on the effects of temperature on fish. They selected 93 F as the maximum that would support a harvestable fish crop. There is good evidence that 93 F is an unrealistically low temperature for survival of warm-water species of fish. A long-range study on the Delaware River sponsored by the Pennsylvania Power & Light Co. has indicated that 104 F may be the lethal limit in that stream.

In addition, experience in Southern states, where water temperatures are 97 F or higher in the summer, has shown no decrease in fish population, despite heavy fishing. Also, the PP & L study disclosed that condenser water flowing from the power plant has converted the river into a wintertime fishermen's paradise.

One may question whether it is in the public interest to maintain conditions that would support a harvestable fish crop in all streams. The rate of growth of sport fishing and aquatic recreation in general is such that it would be foolhardy to propose a regulation that might limit the enjoyment of this highly vocal segment of the population. Moreover, aquatic biologists say that fish will not multiply where water temperatures are consistently over 80 F, even though they may survive levels well above 93. If 93 F were accepted as the maximum allowable temperature, it could be assumed that much of the time the actual temperature would be lower than the maximum.

The advisory committee agreed to adopt the 93 F limit because it was based upon expert judgment, and because data were not available to justify a higher figure on a statewide basis. The committee pointed out, however, that it would be necessary to prescribe mixing zones for heated discharges, beyond which the 93 F limitation would apply. The proposed regulation stated that the receiving water "shall at no time or at any place" be raised above 93 F.

It was apparent that discharge of a minute stream of water above the limit would constitute a technical violation, even though the effect would be unmeasurable. Thus provision would have to be made for discharges that would affect only a portion of a body of water and for a relatively short time. But it was found to be impossible to define a mixing zone equally applicable to every variety of stream conditions. Instead, the committee recommended that the Sanitary Water Board prescribe the boundaries of mixing zones where conditions warrant them.

The committee proposed also, that heat artificially added to streams be limited to an amount that could not raise the total stream flow above 93 F, assuming perfect mixing at the

point of discharge. This would permit calculation of the maximum allowable temperature of a discharge in terms of its volume and the stream flow rate. As a safeguard, the committee recommended that provision be made for increasing or further limiting the heat content of discharges where local conditions would be benefited thereby.

Dissolved Oxygen

A decrease in the concentration of dissolved oxygen is frequently cited by aquatic biologists as an undesirable result of raising stream temperatures. An ample supply of dissolved oxygen is an important feature of a healthy stream, and it is vital to fish propagation. Oxygen is only slightly soluble in water and its equilibrium concentration is inversely proportional to temperature. A saturated solution contains 10.15 ppm at 59 F but only 7.1 ppm at 95 F.

The major demand upon the oxygen resources of a stream is biochemical oxidation of organic matter. The rate of this reaction increases with temperature but it does not necessarily do so indefinitely. It has been demonstrated, for example, that the rate of oxidation of domestic sewage increases with temperature to a maximum at about 86 F and that the rate declines at higher temperatures. Thus the effect of high stream temperature on oxygen resources may be less than formerly supposed.

Misunderstandings have occurred over the amount of dissolved oxygen present in natural streams at particular times. There is often an implied assumption that its concentration will quickly adjust to changes in water temperature. It has also been assumed that its concentration will fall to a low level at night in streams carrying an appreciable load of organic matter. This is supposed to arise from the fact that photosynthetic generation of oxygen ceases at night, whereas the biochemical demand for oxygen continues unabated. Argument on these points can be resolved by the simple expedient of measuring dissolved oxygen concentrations. It is always more illuminating to discuss facts in preference to suppositions.

Personnel of the Water Resources Research Project supported by the American Iron and Steel Institute at Mellon Institute made a series of 24- and 48-hour surveys of a number of local streams in 1960-61. The first series was made on the three large rivers in western Pennsylvania and a tributary of each of them. Samples were taken a foot below the surface at midstream at intervals of two hours and analyzed on site in a mobile laboratory. These surveys were made in June and July, 1960, and summarized in Table I.

TABLE I. DIURNAL VARIATION IN DISSOLVED OXYGEN

Location	Temp., Deg. F	DO, ppm	DO, % saturation
Monongahela R.	71.6-77.9	7.35- 8.25	84.5- 98.5
Peters Ck.	60.8-69.8	7.10- 8.80	73.7- 97.0
Allegheny R.	70.7-79.7	7.00- 8.55	79.8-105.0
Clarion R.	67.1-74.3	7.00- 8.65	78.0- 98.0
Ohio R.	79.7-81.5	7.10- 8.90	87.0-111.1
Little Beaver Ck.	67.1-74.3	6.90-11.85	77.5-128.0

TABLE II. RATE OF HEAT DISSIPATION

Date	Temp.	Mile	Temp.	Mile	Drop	Distance, ft	Deg/ 1000 ft
7/20	94	24.87	87	24.54	7	1742	4.0
7/20	92	19.6	84	19.2	8	2112	3.8
7/20	92	8.9	83	8.6	9	1584	5.7
7/20	91	4.5	83	3.1	8	7392	1.1
8/3	92	24.87	87	24.54	5	1742	2.9
8/3	94	19.6	87.5	19.2	8.5	2112	4.0
8/3	98	4.5	87	3.1	11	7392	1.5
9/7	90	24.87	86	24.08	4	4171	1.0
						Average	3.0

The organic loading of these streams is supposed to range from moderate to heavy. The lowest concentrations of dissolved oxygen occurred at night, but the data show that all values were well above the 5 ppm deemed essential for fish propagation. It was notable that there was a marked increase in dissolved oxygen during daylight hours, because temperatures were highest then.

Similar results were found in three surveys on the Beaver River. The river was about 700 feet wide and several feet deep at the midstream sampling point. Except for a single value of 5.2 ppm, all DO concentrations ranged from 7.7 to 13.1 ppm, corresponding to 60 to 160 per cent of saturation at the water temperature. It was interesting that in both sets of surveys there was found to be at least as much dissolved oxygen present in warm seasons as in cold.

These surveys have demonstrated the impropriety of assuming that dissolved oxygen concentrations always fall to low levels at night in moderately polluted streams. There is no implication that they never do so; it happens that they did not in these surveys. This work illustrates the superiority of data over speculation.

EARLY IN its deliberations the committee encountered a number of practical questions for which it could find no quantitative answers. Among these were the volume of stream water affected by heated wastewater; the rate of natural dissipation of thermal loads; the possibility of using cool subsurface water for fishways; and any tendency for cumulation of artificial heat in streams. It became apparent that useful information on these points could be obtained only from field studies.

A number of companies agreed to make temperature surveys of streams during the summer and fall of 1960. The most extensive of these was undertaken by a joint committee of steel and electric power companies in western Pennsylvania. This survey covered about 100 miles of the Allegheny, Monongahela, and Ohio rivers over a period of four months. The Water Resources Research Project of the American Iron and Steel Institute coordinated the survey and then collated the data that were collected.

Project personnel made a preliminary survey of the three rivers by towing a sensitive thermistor about 20 feet behind a motorboat running 40 to 100 feet from shore. This survey disclosed 18 locations where there were appreciable rises in stream temperature. Nine survey teams were then formed, each to cover two locations. Temperatures were measured with identical thermistors, all calibrated at Mellon Institute.

Measurements were made by suspending a thermistor from a boom projecting over the side of a motor-

boat. The boat was driven across the river at constant speed on a line perpendicular to the shore, with the thermistor successively submerged at depths of 1, 5, 10, 15 and 20 feet. This procedure yielded data for plotting vertical isotherms.

Traverses were made upstream from a discharge and at intervals downstream until the temperature had dropped to a value close to that first recorded, or until another rise was encountered. All locations were covered on the same day to eliminate any effects from variations in the weather.

Survey Findings

The vertical isotherms were so complex and variable from point to point that no valid method could be used to average the data. A very conservative method was therefore adopted to interpret the survey findings. Inasmuch as temperature maxima would be of primary interest to aquatic biologists, the highest temperature recorded at each survey point was plotted against river miles. Data from the Monongahela River are plotted in the graph (on page 40) to illustrate the kind of information provided by the survey. Similar plots were made for the Allegheny and Ohio rivers, but these are not shown here because of the limited number of survey points and the fact that the highest temperature recorded was 88 F.

The Monongahela data show that there was a fairly rapid drop in stream temperature below heated discharges, but that the heat added at one point was not always fully dissipated before another rise in temperature occurred. It has been claimed that heated wastewater tends to raise stream temperatures permanently. The survey showed that this was not true for the three rivers studied.

The temperature of the Ohio in the back channel at Brunot Island (Mile 1.2) is plotted in the right-hand margin of the graph. This channel consists entirely of Monongahela water. This temperature was one to two degrees below that at Mile 40 in three of the four surveys; in one survey (September 7) it was three degrees higher. In the latter case the day began cool and foggy, gradually becoming clear and warm. During the survey period (7 a.m.-1:05 p.m.) the air temperature rose to 78 from 67 F. This undoubtedly caused a natural rise in river temperature.

During the preliminary survey it was found that the normal rise in river temperature from morning to afternoon ranged from two to four degrees, depending upon the weather. Thus it may be assumed that the heat load added artificially was completely dissipated during each of the survey periods. Findings on the Allegheny and the Ohio were similar.

It was desired to estimate the rate of heat dissipation. This was done by tabulating all temperatures of 90 or above and computing the temperature drop per 1000 feet as shown in Table II. Only the Monongahela had temperatures in this range.

It may be seen that there was considerable variation in the rate of temperature decline. This probably resulted from differences in the rate of dispersion of the heated water and from weather conditions. The volume of river traffic would affect dispersion but there was no way to evaluate this factor. In general, the highest temperatures were close to the surface and near the point of discharge. There was only one instance in which a temperature of 90 was found more than halfway across the river.

It had been proposed that one-fourth of a stream must not be affected *at all* by heated discharges, in order to provide a fishway. The survey indicated that such a regulation, if interpreted literally, would be quite impractical. Heated discharges, in a majority of cases, affected the entire width of the river to some extent, but the temperature rise at the bank opposite the discharge was usually only two or three degrees. There must also be considered the result of heated discharges on opposite banks of a river; each user would be entitled to affect up to three-quarters of the river width.

The patterns of the isotherms varied so much that no general statement could be made about the possibility of using cool subsurface water as a fishway. In any event, some aquatic biologists do not feel that subsurface fishways would serve the purpose. Inasmuch as fish kills from heated water alone are relatively rare, the committee recommended that suitable measures be taken where it is evident that heated discharges have a deleterious effect on fish life.

Pennsylvania Regulations

The following regulations, based upon the recommendations of the advisory committee, were promulgated by the Sanitary Water Board in August 1961.

A. The temperature of the waters of the Commonwealth shall not be increased artificially by amounts that shall be inimical or injurious to the public health or to animal or aquatic life or prevent the use of water for domestic, industrial or recreational purposes.

B. The heat content of discharges shall be limited to an amount that could not raise the temperature of the entire stream at the point of discharge above 93 F assuming complete mixing. The heat content of discharges may be increased or further limited where local conditions would be benefited thereby.

C. Where downstream circumstances warrant, the area in which the temperature may be artificially raised above 93 F will be prescribed.

D. A fishway will be required in streams receiving heated discharges where this is essential for the preservation of migratory pathways of game, fish, or for the preservation of important aquatic life.

E. Paragraphs B and C do not apply to streams so impregnated with acid mine drainage that they cannot support a fish population typical of the region except for heated discharges which adversely affect domestic or industrial uses or secondary streams.

F. There shall be no new discharge to waters providing a suitable environment for trout if as a result the temperature of the receiving stream exceeds 58 F or stream temperature, whichever is higher.

G. Reduction of the heat content of discharges to estuarial waters will be required where necessary to protect the public interest. Estuarial waters are those containing ocean salts. Tidal waters not containing ocean salts are considered as fresh water streams.

The procedure that led to adoption of these regulations is one that should be followed more often to solve difficult problems in pollution control. In the present instance, the final result was not achieved easily. Opinions of individual members of the advisory committee were so far apart when deliberation began that unanimous approval of a report seemed unlikely. But rational conclusions can be reached where there is willingness to alter opinions in favor of facts. END

McCarthy, in the white suit, leader of the American Delegation, presided at the session discussing Question 26. At his right is da Rocha of Portugal and at his left is Ito of Japan, and then Mantovani of Italy

WORLDWIDE DAM BUILDERS EXHIBIT LATEST TECHNIQUES

Dick Morris reports from Rome on the 7th International Congress on Large Dams and on highlights of some unique projects

AMID THE SIZZLING, crumbling ruins of Rome, more than 1000 engineers toiled over ways and means to build bigger and better modern structures. Being largely in inaccessible areas it is not likely that 2000 years hence these new structures will have the same tourist attraction as the vainglorious monuments of Ancient Rome, but they will be more utilitarian. They will serve millions around the world with: water supplies; irrigation; protection against floods; and electric power for cities and industry.

The occasion was the Seventh International Congress on Large Dams with the Italian National Committee (Comitato Italiano Grandi Dighe) as hosts. ICOLD, the International Commission on Large Dams, or, in French, the Commission Internationale des Grands Barrages, was originally organized under the auspices of the World Power Conference. Headquarters of ICOLD are at 51, Rue Saint-Georges, Paris IX°, France.

Every third year an international Congress is held to discuss in detail four questions selected earlier by the Executive Committee. The Congress also elects new officers and selects future meeting places. This year Claude Marcello of Milan, Italy, chief engineer of the Societá Edison, consultant of the World Bank and one of the world's foremost dam designers, was elected president succeeding J. F. Rebelo Pinto of Portugal. Two new vice-presidents were elected: John K. Sexton of Canada and Mohmoud Mohamed Gadein of Sudan. Edinburgh, Scotland, was selected as the site of the 1964 Congress, and Moscow was chosen for the 1962 Executive Committee Meeting. The total number of member companies was increased to 46 by the election of Nyasaland and the Federation of Rhodesia to membership.

Just under 1100 delegates from 46 countries registered, nearly half with their wives, giving a total attendance of just over 1500. Following the Congress four study tours were arranged covering various sections of Italy. The Congress opened in classic style in the Campidoglio, or Capitol Building, with welcoming addresses from: Pietro Frosini, chairman of the Italian Committee; Benigno Zaccagnini, Minister of Public Works; V. Ciocetti, Mayor of Rome; and J. F. Rebelo Pinto, president of ICOLD.

Technical sessions began on the second day with discussions of the four questions, Nos. 24, 25, 26 and 27, the sequence being carried on from the first Congress. The general reporter method is followed in ICOLD Congress meetings; that is, the intent is to have all papers preprinted in time for study by delegates. A summary of all papers is presented in brief form by a general reporter so that the remainder of the session may be devoted to discussion.

Altogether there were nearly 150 papers preprinted; about two-thirds were in English, the rest in French. There was, however, general complaint from the reporters that the questions were not adequately and precisely phrased. As a result, there was considerable overlapping of subject matter, with some irrelevant and outdated material both in the papers and in the discussion. The remedy of course lies not only in the phrasing of questions but in adequate screening and control of papers and discussions by the several national committees.

Technical sessions, as contrasted to business and committee meetings, were scheduled to discuss the four questions in numerical order. At the end of each session, the chairman, vice-chairman, general reporter and secretary compiled a list of recommendations for presentation at the final session of the Congress as guidance for future activities.

AGGREGATES FOR LARGE DAMS. Question No. 24 concerned "The Selection, Processing, and Specification

Pope John received the delegates and ICOLD President Rebelo Pinto of Portugal spoke briefly in behalf of the Seventh Congress delegates

of Aggregates for Large Dams." Stalnikov, of the USSR, acted as chairman, with Roa of India as vice-chairman, Pacini of Italy the secretary and Arredi of Italy as general reporter. Thirty papers from 15 countries had been submitted. Some of these described specific construction jobs, methods of testing, preparation, sizing and use. Others summarized national experience over a period of years with a multiplicity of construction jobs for dams of various types.

Aggregates are as important as cement in assuring the quality of concrete and are also about twice as expensive, so there was wide interest in this question. A great deal has been written and many tests made on the ideal type of aggregate. The practical solution, however, rests on economic considerations and available material. Today, aggregates of the most varied physical characteristics are being utilized and rarely does available material prove completely unsuitable. Usually it is the judgment and attention in planning and operating the aggregate plants rather than the properties themselves that prove the final suitability.

In general, processing and usually the final selection of aggregates are the responsibility of the contractor, provided the predetermined quality of the concrete is obtained. There does, however, seem to be a general trend for the engineers to investigate several sources in advance to assist the contractors in bidding and insure the desired quality of the final product.

Both natural and artificial crushed aggregates are widely used in all countries. Tabulation of some 70 dams in Japan showed 31 made from natural aggregates and 39 from crushed aggregates. While there is some minor variation between countries, there are, in general, five size classifications, ranging from the maximum of 6 in. through a series of 2 to 1 reductions down to a minimum of 0.2 in. Usually most of the flour or dust is discarded although a small proportion of this is usually desirable to increase the workability of the mortar. The lower the cement content the more accurate the aggregate grading must be.

While 6 in. is more or less a general maximum size, 3 in. has been set as the maximum limit on some slender structures. Portuguese tests indicate that the addition of aggregates above 6 in. does not reduce the mortar, but that reducing the maximum size to 3 in. materially increases the cement content necessary. This is not entirely in accord with experience in India and particularly in Germany, where large solid rocks up to 16 in. are used. The advantages given for this cyclopean concrete are: lower cement content; reduced shrinkage; limited heat generation; and improved impermeability and frost resistance. It is said that 36 per cent by volume of coarse rock can easily be incorporated without undue difficulties.

Shape of the aggregate is an important factor, and cubical or spherical particles are the most desirable. Swedish tests confirm the importance of the equipment used. A flat angular product is apt to be obtained if the feed is slow so that the particles are crushed by the plates. A better shaped product is obtained when the working section of the crusher is completely full so that the particles are kneaded and pressed against each other. Desirable and undesirable particle shapes can be segregated by a sloping chute.

The Japanese supply an interesting comment on rod mills used for sand preparation. If energy consumed remains constant, the mills have a characteristic such that the fineness modulation varies according to the quantity of the material fed into the machine. This fact is utilized to regulate the sand grading exactly, without screening or water separators.

FINDING SPECIFIC SURFACE. In concrete preparation, the specific surface is an important factor, and Czechoslovakia reports an interesting method of determining this on a type of aggregate with extremely rough and irregular shapes. The aggregate particles were covered with a film of mineral oil and a very thin uniform layer of bronze powder applied. The amount of bronze powder used, compared with that used in a similar way on small metallic balls of the same grading, gives a measure of the specific surface of the aggregates.

Variable moisture content of sand creates considerable difficulty. The Japanese reported an interesting continuous meter for direct measurement of the moisture content of sand. This consists of a neutron source of radium and beryllium placed at the end of the sand storage bins in the mixing plants, plus a detector counting the number of neutrons slowed down by hydrogen atoms. Thus the total content of the water including crystallized water is obtained. The results of the measurements have been checked and found to agree with the drainage method tests. The operation of the meter, however, is disturbed by several factors and additional experimental work will be required to develop it for routine commercial operation.

While concrete is the most commonly used material for dam construction, wide use of masonry or dressed quarry stone using lime and "Surki" mortar was reported from India. Surki is produced by burning a high quality clay, ground firmly and mixed with freshly burned lime, usually in the proportion of one part lime to two or three parts surki. Usually no sand is added to the mortar and it must be used the same day.

The USSR made a plea for increased emphasis on standards or specifications. They stated that these had been used to advantage in the USSR with various modifications since 1949. These standards consider: various types of concrete in relation to the different parts of hydraulic structures; limits for certain salt contents in mixing waters; quality requirements; methods of investigating aggregates; method

of concrete testing; and basic principles of proportioning.

While most countries have standards of specifications for various details, the move for more comprehensive or international standards did not receive much support. The general consensus seems to be that it is desirable to draw up standards for each project once the aggregate supply is known and tests have been made. Because of the great variety of technical and economic conditions affecting aggregate supplies throughout the world, investigation and tests are necessary for each individual project and no specifications or standards would eliminate this need.

Opening in the Campidoglio, l-r, Frosini, head of DIGA; Zaccagnini, Min. of Public Works; Cioccetti, Mayor of Rome; Pinto, head of ICOLD

FOUNDATIONS. Question No. 25 concerned all phases of "Underground Works in Connection With Large Dams." The chairman was Oliver-Martin of France, the vice-chairman Ospina of Colombia, the secretary, Fenelli of Italy and the general reporter, Lawton of Canada. Thirty-eight papers from 18 countries had been submitted. A large proportion dealt with the theoretical and practical aspects of rock mechanics and rock improvement although a sizable group was devoted to tunnel construction and underground power plants.

In a dam, the foundation is normally the weaker element because adequate computational and experimental bases for the design of dams are available but only imperfect bases exist for reliable design of foundations. The information available is not readily reduced to numbers, so that a substantial element rests on judgment. Because of the uncertainty of determining rock conditions, these uncertainties are frequently paralleled in the design and construction of: large power tunnels; pressure conduits or penstocks placed in rock; and underground chambers for the accommodation of generating units, valves, hydraulic gages, and transformers.

Specific examples of tests *in situ* by means of strain gages, jacks, stressed cables and test galleries were described. One of the most promising of these, an Austrian development, is a radial jack that can be loaded to 10,000 tons, gives excellent measurements, and can be used quickly at various places and at reasonable costs.

Theories originally developed assumed that, in a rock mass for a powerhouse or tunnel, the stresses would be hydrostatic in nature. This is far from the case. Locked-up stresses arise from the loading of the particular rock and have usually a specific bearing on its utilization as an engineering material.

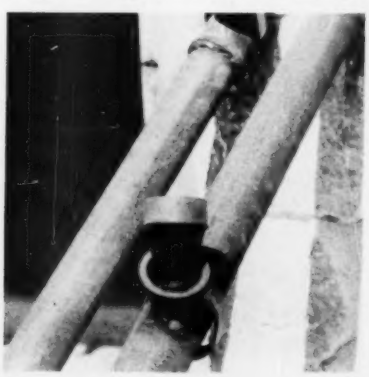
For tunnels crossing soft ground or heavily fractured rocks, the USSR has developed and uses an oval cross section with the long axis horizontal and made up of two semicircles with rectangular inserts. The proper design is said to reduce the lining thickness by 22 per cent in comparison with the usual cross section.

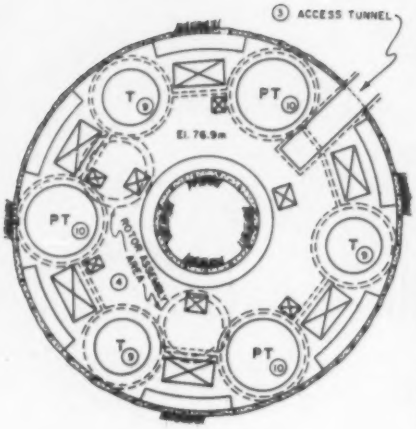
Underground plants are rapidly increasing. During the discussion, there was mention of 10 in the USSR and 29 in Yugoslavia. One of the deterrents, of course, is the high cost of excavating rock, but this is steadily decreasing as techniques and designs improve. During the discussion, an installation in Czechoslovakia was mentioned with an expected volume of 0.15 cu yd per kw of capacity. That this is quite practical is indicated by figures from a proposed installation in Tasmania of around 0.17 cu yd per kw of capacity.

As a rule, underground turbine rooms are rectangular, usually lined with concrete. One of the interesting innovations and one of several possibilities studied in connection with the Oroville plant in the U.S. was six turbine units arranged in a circle around a massive rock pillar 50-ft in diameter to support the roof of the plant. This resulted in an excavation the shape of a doughnut or torus. In the main machine hall, the excavation was given as 132,000 cu yd, which, on the basis

These two 75,000-kva Pelton units in the Valpelline Station of the Buthier System were shut down to avoid disturbing buffet lunch diners

Rubber valves used at the Valle di Lei Dam for regrouting the structure. Two types of rubber are used





PLAN ①

An toroidal underground arrangement for turbines and pump turbines. The central rock pillar has 50-ft diam

of initial 420,000 kw, gives a volume of 0.3 cu yd; or, on the basis of the ultimate capacity of 600,000 kw, a unit excavation of 0.22 cu yd per kw.

THREE SOVIET PROJECTS. In proposed underground designs using a small cylindrical foundation, units in line, liberal use of prefabricated parts and a low-head crane, the USSR feels that very great future savings can be made in underground practice. Among the future projects in the USSR with underground structures is the Ingouri station on the Ingouri River. This is a proposed 1000-ft dam with a 6-mile tunnel to the power plant. The tunnel ranging from 33 to 55 ft in diameter will be unique, and the head on the Francis turbines will exceed 1300 ft.

A second USSR plant is the Nourek station on the Pakhsh River, at present under construction and planned for nine units with a total capacity of 2,700,000 kw. This too will be a 1000-ft dam but with a head on the plant of about 675 ft. The third plant is the Tcherky station on the Soulak River, also said to be under construction. The dam is about 675 ft high. All three dams will be made of local materials; that is, earth and rock filled.

WORKING IN WIDE VALLEYS. Question No. 26 was concerned with "Modern Techniques of Concrete Dams for Wide Valleys and Ancillary Works." McCarthy of the U.S. was chairman, Ito of Japan, vice-chairman, Mantovani of Italy was secretary and the general reporter was Rocha of Portugal. Thirty-three papers from 17 countries were submitted. Different interpretations of wide valleys broadened the coverage much beyond the original intent of the question.

A diversity of physical conditions precludes the use of any one method or type for dams in wide valleys. Practically all types and combinations have been used successfully, and the preference to a certain extent is influenced by the economic factors of cement costs and labor costs for forming.

Thus, in the U.S. mass concrete techniques and large earth-moving equipment is a factor. Earth and rock-fill dams are strongly favored, although solid gravity dams are frequently the most economical solution. In India, where most of the dams are in wide valleys, masonry is preferred. Stone masonry dams with lime-surki mortar are built without joints in dams of over a mile and a half in length. Masonry dams with cement mortar are jointed at 60 to 120-ft intervals.

In Europe, solid gravity dams are seldom used, but massive head buttress dams are preferred where arch dams are not practical. Substantial reduction in volume is achieved, but this is somewhat balanced by higher unit cost of concrete and shuttering. Buttress dams are favored in Scandinavia and are widely used in Switzerland and Italy.

Pre-stressed gravity dams seem to be of great interest, but experience available is very limited. The Catagunya dam in Tasmania is being built with the buttresses anchored by vertical cables. The design is estimated to cost some 20 per cent less than a conventional gravity dam. Cables were protected before stressing with grout, and selected cables are being equipped with electric resistance-measuring indicators to give prior evidence of corrosion should it occur.

From the various papers presented, the general reporter drew the conclusion that arch dams are technically feasible in wide valleys even with apertures exceeding 10. The aperture is defined as the ratio of the length of the cord to the height of the dam. Obviously with very large apertures the volume of the dam approaches that of the solid gravity dam.

MULTIPLE-ARCH DAMS. At present, one of the most promising prospects of concrete dams in wide valleys lies in the adoption of large-span multiple-arch structures. The general reporter feels that it is possible that they may become competitive with earth dams. Studies in Portugal lead to the conclusion that multiple-arch and independent-buttress dams may give economies in the volume of concrete as high as 40 per cent for a buttress dam and 7 per cent for a multiple-arch dam and with smaller excavations.

The most promising solutions seem to lie in the use of non-reinforced concrete, double-curvature arch with long spans, although these designs still present problems. Studies underway show that multiple-arch dams with large spans, in which the ratio of span to the height might be up to or more than two, may be built with safety.

Multiple-arch dams have been built with gunite in France with success. Construction operations are simple and rapid. Arches have been built with the uniform thickness of 1 in. and it is said that this type of construction is adaptable for multiple-arch dams with heights up to and over 60 ft.

In the USSR, many of the large dams are built on sand or earth foundations. The general practice is to build the overflow dam and powerhouse structure on the banks outside of the river bed and protected by low dams. The river is then closed with an earth dam and the water diverted through a channel excavated in the banks to the outlets of the overflow dam. This method precludes the necessity of two phases of construction simultaneously under protection of complicated coffer dams, but at the expense of somewhat bigger volumes of earth work. It is, however, possible to cut down the construction time to make the operation simpler and cheaper.

In all phases of construction and industrial work, the USSR stresses prefabrication. During discussion, great economies were claimed for a type of dam which could be built in quick time, required no forms, and reduced the labor costs three to four times. This construction involves thin wall concrete cells made of prefabricated panels, placed with a crane and filled with earth or rock to provide the necessary weight.

SEALING TECHNIQUES. Question No. 27 covered the practical aspects of "Sealing of Earth and Rockfill Dams with Bitumen and Other Materials." The chairman was Selim of the United Arab Republic; vice-chairman, Eeman of Belgium; secretary, Gallo of Italy, and the general reporter was Bertram of the U.S. Twenty-two papers were presented

about this topic from 13 countries.

Sealing is interpreted as provision for a waterproofing element on the upstream face or the interior of an embankment. It is also the treatment of the foundation to minimize seepage. Half of the reports dealt with bituminous materials and bituminous concrete for waterproof facings. The other reports covered other aspects of the question, including: foundation treatment by grouting; seepage control by means of upstream blankets, sheet pile cut-offs and downstream drains; impervious linings for high-level pumped-storage reservoirs; waterproofing of embankments by means of steel facings, reinforced concrete facings or precast concrete facings with plastic liners; and sealing of embankments by means of centrally-located earth cores. Bituminous grouting or injection of bituminous emulsions have been used very successfully to depths of 35 ft, but temperature and consistency control can be a major problem.

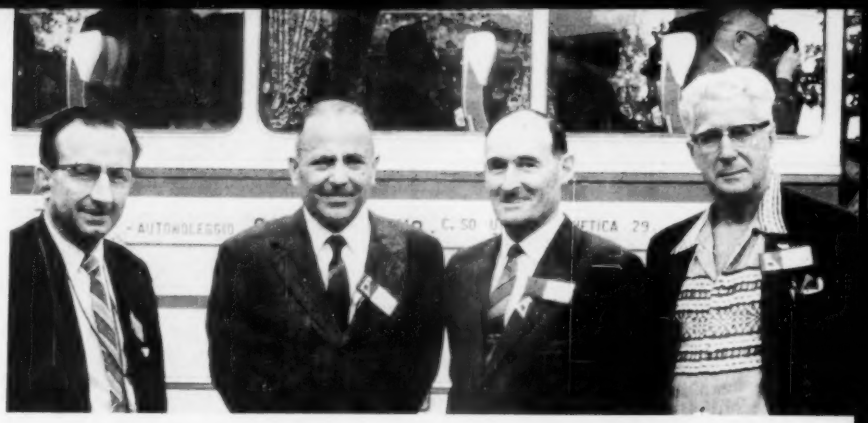
On an experimental dam in Czechoslovakia, plastic fillers have been used to form a continuous waterproof membrane between two layers of corrugated pre-cast concrete slabs. It would appear the system is well adapted to embankments of small total settlement and deflection.

Bitumen has been used for many years as: a protection against erosion in lieu of rip-rap; as an impervious waterproof facing; as an impervious membrane between two concrete slabs; and as an internal core. Aging of bitumen is a factor which has been subjected to a great deal of investigation. Examination of samples taken 18 years after construction show that cohesion and stability improve with age; that imperviousness is unaffected by the passage of time but that plasticity and flexibility decrease over the years. Aging is accelerated by exposure to air while submerging retards the process.

The effectiveness or advantages of vibratory rollers over rubber-tired rollers for compaction was reported from Norway. During the early part of construction, fill was compacted by rubber-tired rollers. Field tests demonstrated that vibrating rollers would give comparable densities with layers twice as thick.

The general reporter concluded that no data were presented to alter the conclusion that the most desirable form of foundation treatment is a positive vertical cut-off by grouting. Where the economy of the project does not permit such a solution, less effective methods were upstream blankets and drains, which afford a practical means of minimizing the seepage loss.

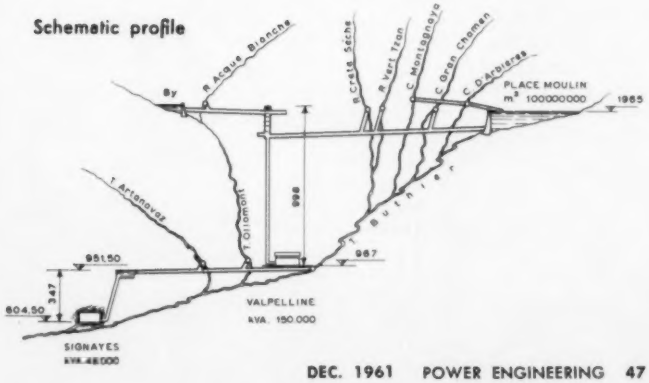
Following the Congress a series of four study tours approximating a week each were scheduled. Tour No. 1 to northwest Italy roughly paralleled the entire common border with Switzerland and further details of this tour are covered below. Tour No. 2 was to northeast Italy; Tour No. 3 covered central Italy northeast of Rome and circled Sardinia, and Tour No. 4 was to central Italy southeast of Rome and circled Sicily.



Outside the ISMES installation, l-r, Ted Mermel, U.S., of Large Dams Register; Claudio Marcello, Italy, new ICOLD President; G. T. Colepatch, of Tasmania Hydro; and Dick Morris, of U.S., and of Power Engineering

Mt. Blanc from Italian side above Courmayer, showing entrance to the tunnel under the mountain to French side. Below: Schematic profile of Buthier System, typical of small-flow high-head Italian systems. All dimensions are given in meters

A SCENIC POWERSCAPE. Study Tour No. 1 to northwest Italy approximated 1500 miles by train and bus



in eight one-night stands. This gave a detailed coverage of the rugged Italian-Swiss border area from the French Mt. Blanc on the west to Bormio just south of the Austrian border on the east.

This is the land of glaciers, steep slopes, small flows and high heads. Scores of small streams, "torrenti" in Italian, are gathered together by miles of tunnels and canals to make what we would call a good-sized trout stream. These relatively small flows, dropped down hundreds or even thousands of feet, supply a goodly share of power for the industries and cities of northern Italy.

Altogether, visits to 14 installations were scheduled, all but three being dams or hydroelectric stations. One of the exceptions was the Santa Barbara steam station near Florence. Another was the Mt. Blanc tunnel, a joint venture of the French and Italians. Each side has now been driven approximately two miles under the mountain, somewhat less than half the total length.

The third exception was the experimental model testing laboratory (ISMES — Instituto Sperimentale Modelli e Strutture) at Bergamo. This Institute, established a decade ago to test the structural design of dams by means of models, has earned worldwide recognition. Models of dams from all over the world have been tested.

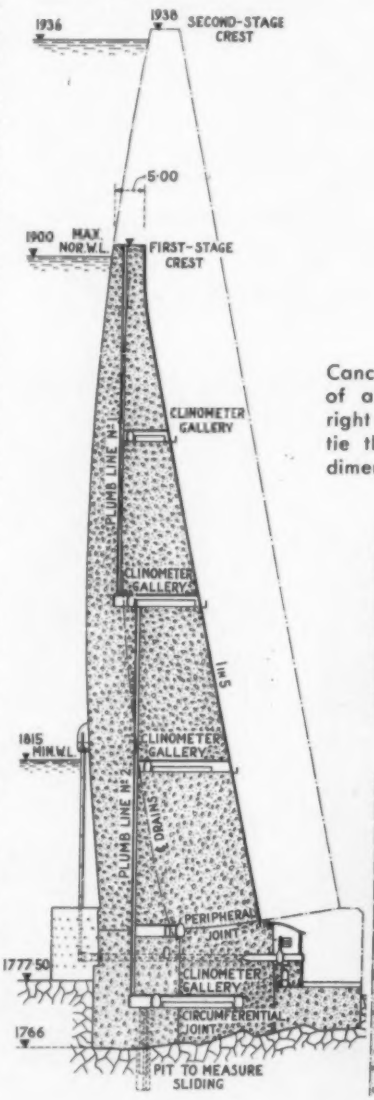
All the installations visited had features which warranted their selection as tour sites. Selection was not a simple matter in a region where practically every turn in the road brings a dam, power plant, penstock or intake of some kind into view. Space permits mention of only a few which were selected as typical of some feature of Italian practice.

In the shadow of Cervino, which the Swiss call the Matterhorn, the Buthier River system illustrates the intense development of a small watershed, 21 miles long and 7 miles at the widest, into a system of nearly 200,000 kva under a total drop of over 4000 ft.

Seven diversion dams, also one small and one large storage dam, with two powerhouses, complete the system. This was a joint development of the City of Turin, the State railways and a State industrial complex. The Lower Buthier system, with the underground Signayes plant of two Pelton units operating under a head of 1138 ft, was put into service in 1951.

The Upper Buthier system, which partially feeds the lower system, went into partial operation in 1958. When completed, the two double Pelton units in the Valpelline Station will operate at a head of 2994 ft and develop a total of 150,000 kva. The Buthier Electric Syndicate were hosts for a lunch at this station, a courtesy doubly appreciated by the surprised visitors when both units were taken off the line so the noise and vibration would not disturb the diners nor interfere with the short and gracious speech of welcome.

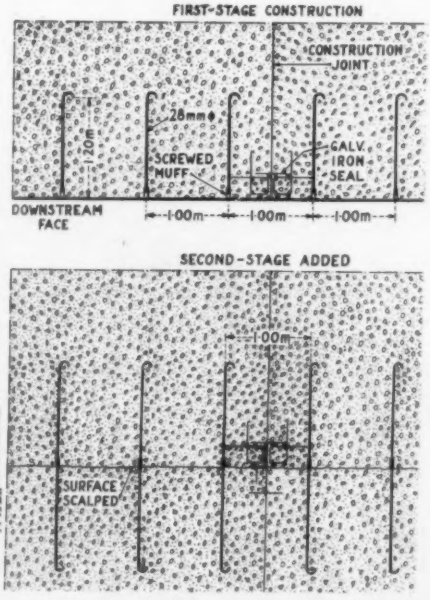
The final and essential step to provide year-round operation of the system is the upper and major reservoir, which will be formed by the Place Moulin dam now under construction. This arch dam with a crest of 2066 ft will rise 499 ft above the foundation and have a volume of 1,865,000 cu yd of concrete — 1/70th of the reservoir storage capacity!



ACTIVITIES OF SIP. In the same general area SIP, the Societá Idroelettrica Piemonte, built the Beauregard arch dam 433 ft above the foundation, supplying water to the Avise underground station under a head of 3412 ft. The station capacity is 160,000 kva consisting of two 45,000-kva single Pelton and one 70,000-kva double-wheel unit. The activities of this company and its associates in wide interconnection practice are shown by the fact that this Avise station is but one of 14 stations on a system totaling 1,994,000 kw. The company is also one of the participants in the 150,000-kw SENN (Societá Elettronucleare Nazionale) atomic station being built at the mouth of the Garigliano River. SIP will receive one-quarter of the output of this enriched-uranium boiling-water dual-cycle plant.

In contrast to projects of private and publicly-owned utility systems, the so-called Falck's Group (Acciqierie & Ferriere Lombardi Falck Co.), while developing their iron and steel plants, built heavy power facilities. Since 1917 they have built a series of hydroelectric plants with an annual output of nearly a billion kilowatt-hours. One of their projects, recently completed, is the Frera Dam on the Belviso Torrente just south of the village of Aprica and, like so many recent projects, near the Swiss border. This is an arch

Cancano II Dam was designed for the addition of a second stage later. The detail at the right shows the capped rods which will later tie the first and second stages together. All dimensions and elevations are in metric units



dam rising 453 ft above the foundation.

Again the dam and reservoir are the key factors in year-round operation of the system, built around a natural and diverted 43-sq-mile watershed. The total drop of 3525 ft is divided into two nearly equal steps, with an installed capacity of 30,000 and 35,000 kva, respectively, in an upper and lower power station. A 10,000-kw pumped-storage plant unit is planned later to return water from the small intermediate storage to the Frera Reservoir.

Quite as intriguing as its name is the Cancano II Dam, the second of the Azienda Elettrica Municipale of Milan. As long ago as 1906 this city began developing the River Adda in a watershed that runs north from Tirano to the Swiss border. The extremity of the watershed is the divide between the Black Sea watershed via the River Spöl and the Adriatic watershed via the Adda. In fact, some of the drainage is a diversion from one watershed to the other, compensated for by international agreement to avoid changing the total flow to each.

Cancano I was built in 1928, and in 1950 a buttress dam, San Giacomo, was built upstream to nearly double the storage capacity of the upper system. Cancano II, recently completed, floods out Cancano I and toes up to San Giacomo. The storage capacity was again nearly doubled. Cancano II is an exactly symmetrical arch dam, 16.40 ft thick at the crest, rising 440 ft above the foundation and containing 688,000 cu yd of concrete.

SOME INTERESTING FEATURES. First, the model test at the ISMES showed such stability that the crest level was raised 13 ft. Second, the dam is designed for a second stage to be added to raise the crest level an additional 118 ft in the future. Third, the upstream side is faced with granite blocks to protect against ice damage.

The downstream side is left exposed, and a series of hooked tie bars have been cast in, with the ends protected by screwed caps. When the second stage is poured, these caps will be replaced with sleeves to join mating bars cast in the new wall. The purpose is not so much to join the new faces as to prevent the two faces being forced apart when the joint is grouted.

The corresponding power station is the underground Premadio with a total of 150,000 kw in two double Pelton units operating under a maximum head of 2263 ft. The underground location is said to be purely a matter of economics, due to the schist formation at the site and faults communicating with underground thermal springs. The turbine hall is horseshoe-shaped in cross section and lined with concrete. The excavation ran about 0.6 cu yd per kilowatt of capacity, but this will be reduced to about 0.46 cu yd when the station is completed to its full capacity of five units totaling 375,000 kw.

However, the most important feature of the installation is the location of the main transformers adjacent to the units and connected to the outdoor switchyard by 250-kv oil-filled cable. The direct leads to the 10/245-kv transformers make an integral generator-transformer unit of extreme simplicity. The oil-filled 250-kv cables run through a 1085-ft long inclined tunnel to the switchyard. There is a difference of 164 ft in elevation between the two ends so the lower ends of the cables are reinforced to withstand the extra pressure.

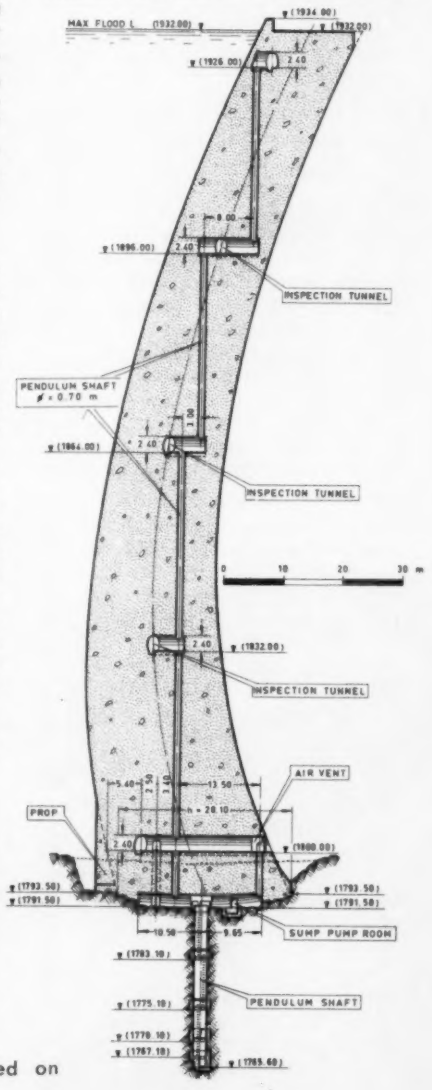
VALLE DI LEI PROJECT. While the Cancano project involved a bit of international horsetrading of water, the Valle di Lei project, north of Lake Como where Italy thrusts deep into Swiss territory, rivals the international complications of some of the proposed projects on the lower Danube.

This is a joint project of the Societá Edison of Milan and seven Swiss power companies. The Italians designed and built the main dam and storage reservoir. The Swiss are building three power stations with a total generating capacity of 640,000 kw, and some intermediate works. The main reservoir is fed from the Italian watershed of the Runo di Lei with some diversion from the upper Avers watershed in Switzerland through free flow tunnels.

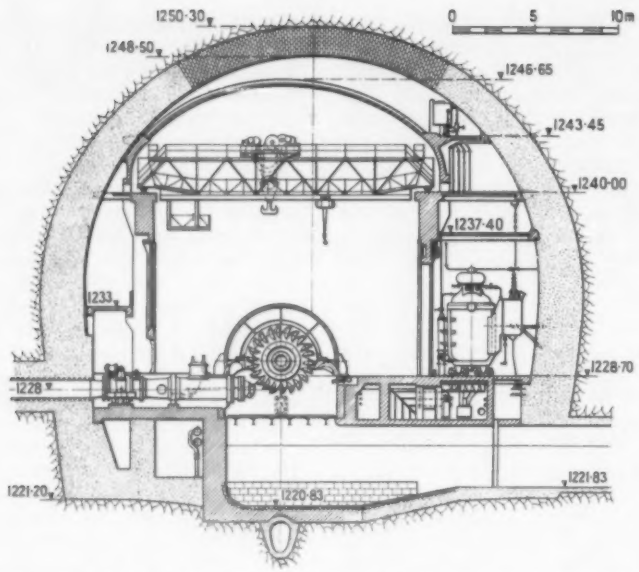
This is a pumped-storage project, pumping Swiss water from several watersheds back into the Italian storage behind the Valle di Lei Dam. When completed the Valle di Lei Dam and intake areas will be ceded to Switzerland in exchange for comparable areas elsewhere. The Societá Edison will receive 20 per cent of the energy for their participation.

The dam itself is of the arch gravity type with a crest of 2263 ft, said to be the largest of its type yet built. It rises 469 ft above the foundation and has 1,129,000 cu yd of concrete. The left shoulder has a thick overburden of moraine and talus, and a gravity shoulder was provided to support the top arches. Aggregates were prepared from local limestone quarries, using the dry method. It is estimated that this prolonged the pouring season a month and made it possible to complete the dam a season ahead of schedule.

Very complete instrumentation to detect stress and deformation has been provided, including an inverted pendulum. This device, developed by Claude Marcello, the chief engineer of the Edison Company, designer of the dam and president-elect of ICOLD, consists of a wire fixed at



Cross section of the Valle di Lei Dam. Swiss military authorities insisted on increasing the crest width to 33 ft. Dimensions are in meters—3.28 ft



At underground Premadio Station transformers are next to generators and tied to the switchyard by 250-kv cables. Dimensions in meters

the bottom and held under tension by an inverted bell, sealed by liquid and free to move at the top. The top thus follows the bottom movement accurately, and the installation is much more convenient than a conventional pendulum. Rock deflection due to the weight of the dam was nearly half an inch. The reservoir has not yet been filled, so measurements showing the effect of the added water pressure on the rock deflection are not available yet.

Regrouting is common practice in Europe, and several special valves for this purpose are in use with more or less success. Regrouting was doubly important at the Valle di Lei Dam because of the large overhang on the downstream side. It was necessary to keep each course stressed in order to keep sections of the upstream side from being in tension. Several different regrouting valves were used, some showing a failure of over 50 per cent. After experimenting, a hard rubber plug shaped as the frustrum of a cone and topped by a soft-rubber cushion was developed. These were used throughout with a loss of only about 3 per cent of the valves.

The rubber valve sets in a cone welded to the grouting pipe in such a manner that the end of the rubber valve is about flush with the inside of the grouting pipe. The soft-rubber top compresses under the grout pressure and closes afterward. After grouting, the pipe is flushed and the flushing pressure is then raised momentarily to flush the valve. This leaves the system ready for regrouting.

Run of river Isola Serafini uses a loop in the River Po to advantage

ISOLA SERAFINI PROJECT. As a change of pace from mountains and high dams, on the final Sunday the tour ended in a run-of-river plant on the River Po with Mass celebrated in the partially-completed turbine hall. With some 70 per cent of Italy's potential hydro power developed, few if any fuel resources, and a growing power demand, the more expensive projects must be developed. The Isola Serafini development takes advantage of a 25-ft drop across a narrow neck of land formed by an 8.5-mile loop in the River Po.

The cost of the project, 16 billion lire, runs to about $500 per kilowatt of installed capacity. The total cost per kilowatt-hour is estimated at 60 lire or one cent, about the economic borderline where hydro is justified. Contrary to most Italian hydro plants which carry the peaks, this will be a base-load plant and is located in the load center where transmission costs and losses are low.

Four Kaplan units designed to operate over a range of from 11 to 25 ft will give a total installed capacity of 50,000 kw. The available yearly output is estimated at 300 $\times$ 10^6 kwh. The project consists of what is termed a slotted-weir dam across the river, a third of a mile tailrace across the neck of land and spanned by the powerhouse structure and a navigation lock.

This diversion dam is 3000 ft long and the forebay 354 ft wide. The powerhouse structure is on the right bank, with the longitudinal axis set about 60 degrees to that of the dam. The river is heavily diked at this point and high water level is above the surrounding land. This, combined with the gravel and sand earth structure to an indefinite depth, made construction and design especially difficult.

Piers and cutoff walls for the dam rest on concrete caissons, pre-cast on the shore and floated to the proper location. Two cutoff walls, 43 ft high and spaced 82 ft apart, were sunk between caissons. Space between the walls was excavated, a layer of concrete poured under water, the compartment was unwatered and the final pour made to form a stilling basin to dissipate water discharged under the sluice gates.

Flat gates were used to give stability to what amounts to a floating structure. Six of the eleven gates are provided with automatically-operated flaps. Two of the gates nearest the powerhouse have the sills 1.6 ft lower than the others and are intended to keep the powerhouse intake free of gravel.

After this visit and a lunch with SIMA (Societá Idroelettrica Medio Adice), the promoters of this project, as host, the Tour departed for Rome. The midnight arrival ended eight crowded 7 a.m.-to-11 p.m. days, made pleasant and profitable by the graciousness and hospitality of the electric company hosts and the planning of the Italian Committee of Large Dams—Comitato Italiano Grandi Dighe. END

TANDEM MOTOR-TURBINE DRIVE FOR AXIAL-CENTRIFUGAL COMPRESSOR

R. V. Endres and C. M. Smith of Allis-Chalmers describe a unique line-up for oxygen generation

UTILIZATION of an axial-centrifugal compressor arrangement for large on-site oxygen generating plants has been successful in meeting the prerequisites of low brake-horsepower and continuity of service. For applications when the inlet volume requirements are in the 35,000 to 105,000 cfm range, and pressure requirements are in the 70 to 100 psig range, an axial-centrifugal can be used most efficiently and economically.

Over-all system efficiency is comparable to that obtainable with isotherm centrifugal compressors, while less heat exchanger maintenance is required. At present, these volume requirements, especially on the higher side, cannot be handled with any single isotherm compressor on the market. To attain such volumes, several isotherm compressors would have to be paralleled to supply enough air for the system. Higher initial costs, higher maintenance, and, in general, a more cumbersome installation would result.

In a large Southeastern on-site plant, air from the main air compressor combination is converted to both high and low purity gaseous oxygen. The tandem arrangement is rated 71,700 acfm inlet air measured at 14.3 psia and 95 F and discharges at 98.2 psia from the centrifugal discharge flange. The system requires approximately 13,485 brake-horsepower when running at 4800 rpm.

This unique line-up is driven by a mechanical-electrical system. A 9500-hp, 4800-rpm, multi-stage, mixed flow condensing steam turbine is directly coupled to an eight-stage axial compressor. This, in turn, is directly coupled to a four-stage centrifugal machine as shown in Fig. 1.

FOLLOWING the centrifugal machine and connected through a gear is an Allis-Chalmers induction motor rated 4000 hp, 1200 rpm, 3 phase, 60 cycle, 4160 volt. This motor supplies additional power for full load operation since not enough steam is available for a full capacity steam turbine. Figure 2 is a schematic of the system layout.

Discharge air from the axial is cooled down to 100 F in two paralleled heat exchangers. Air from the centrifugal is cooled down to 95 F by a single air to water exchanger. Moisture entrainment not taken out by the heat exchangers is eliminated by moisture separators located downstream of each exchanger.

Turbine is designed to take steam at 450 psig, 700 F, and exhaust at 3 in. Hg abs to a barometric counterflow cascade condenser. Depending on auxiliary steam demand, up to 125,000 pounds per hour of induction steam is available at about 10 psig.

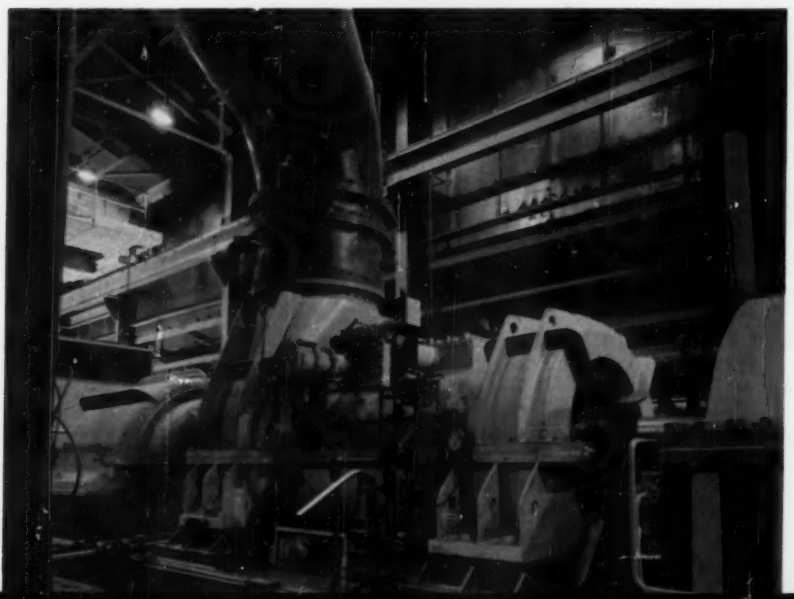
Compressor load studies indicated that the load would be fairly stable and would not subject the prime movers to undue load swings. However, steam supply to the turbine could vary in such a way that it could lose 2000 to 2500 horsepower for short periods of time — less than one minute. These load swings can subject the drive motor to 150 per cent to 163 per cent full load rating and have to be absorbed by the drive motor.

Selection of the 4000-hp, open self-ventilated induction motor was made because of the ease of control, absence of pull-in problems, inherent greater torques, less complex equipment, no slip rings or brushes, and drive system flexibility. It has *Silco-Flex* insulation with a 60 C temperature rise in a 40 C ambient on continuous load.

DRIVE MOTOR will be de-energized during periods of operation when the steam turbine can supply the total load requirements. Rotating elements of the gear and motor will then be "freewheeling." For expected long periods of compressor operation when the motor is not needed, it is possible to disconnect the flexible coupling at the high speed shaft of the gear. This will result in saving approximately 100 hp, which represents the friction and windage loss of the gear and motor.

Because of the high inertia of the drive system, the motor cannot accelerate the mass from zero speed. The turbine is used for start-up and the motor starting breaker must therefore be closed at some predetermined speed. The motor breaker is interlocked with a centrifugal speed switch on the motor

Fig. 1. Tandem arrangement has motor at left end, followed by centrifugal and axial compressors. At right end: condensing steam turbine



shaft, closing the breaker at 85 per cent of synchronous speed. With the steam turbine supplying the load requirements, the motor can then accelerate the system from 85 per cent speed to full speed.

A SECOND CONSIDERATION on motor starting was the kva inrush. This had to be limited because of the incoming power system characteristics. Energizing the motor at 85 per cent speed automatically accomplishes this requirement. Figure 3 shows the approximate per cent speed versus per cent motor current characteristic. It is seen that at 85 per cent speed the current is about 440 per cent, compared to 650 per cent at zero speed.

Full adjustable stator blade control on the eight-stage axial machine permits wide capacity variation at 100 per cent speed operation with little sacrifice in machine efficiency. Until adjustable stator blade control was developed a few years ago, the acceptance of the axial compressor was limited because of the inherent steep (essentially constant volume) pressure-volume characteristic curve.

Now, when the stator blades are at maximum setting, it is possible to operate at approximately 50 per cent volume and 100 per cent pressure-rise by moving the stator vanes to minimum setting. Performance curve in Fig. 6 illustrates this. This range of operation is normally desired for main air compressors in oxygen plant service. Usually, peak oxygen demand periods are followed by recessions in the oxygen demand curve. Therefore, it is not necessary to operate at full capacity all the time. Likewise, with standby storage tanks filled with liquid oxygen, it is not necessary to have over-size compressors available to handle the maximum but intermittent peak periods of operation.

Weight flow variation is obtained while the machines are running by merely operating a spring loaded two-way switch on the stator blade manual control sub-panel. Simultaneous motion is thus instigated hydraulically to eight large bull rings (one for each stage) that surround the cylinder liner on the axial compressor. When the switch is actuated the hydraulic positioner moves in the predetermined direction until the blades have reached their maximum or minimum setting. The hydraulic power cylinders on the axial machine are shown in Fig. 1.

FOR EVERY BLADE there is a bushing and a graphite lever with a U-shaped slot on one end. The bushings are mounted on the bull rings and the U-shaped slots ride against the bushings. The other ends of the levers are rigidly fastened to the blades and as motion is imparted to the bull rings, the U-slots slide against the bushings causing the blades to rotate. Figure 5 shows the top half casing and first half of upper stator liner removed on the axial.

Zero or base setting of the blades (see Figure 6) is the design setting and dictates the speed of the compressor. The efficiency contours are such that a conventional oxygen plant system resistance line can be superimposed within this p-v envelope with less than a 5 per cent efficiency variation from 100 per cent flow down to 50 per cent flow.

Because of the dual drive setup, low temperature and low weight flow points are obtained with suction throttling rather than variable speed. While the adjustable stator vanes on the axial are at minimum setting, the suction butterfly valve located in the suction line of the axial is "pinched" closed until the desired operating point is attained. This valve is interlocked so that it cannot be closed until the axial stator blades are at minimum setting and valve closing is accomplished with another spring loaded two-way switch on the suction throttled valve manual sub-panel.

Surging of the compressors is prevented by means of a preset blow-off valve with associated controls. The control senses discharge pressure and as the pressure rises, the valve opens and prevents the compressors from surging.

Assuming each machine is supplying its full rated load and the motor circuit breaker is tripped, the turbine would be subjected to an additional 4000 hp. To relieve the turbine overload condition, the stator blades on the axial compressor are interlocked with the motor tripping circuit so that they move to the minimum position upon deenergizing the motor.

A contact-making ammeter has been provided as part of the motor control to give an indication of motor load. This device is adjustable between 3000 hp and 4300 hp and energizes a "local" and a "remote" indicating light. The operator is therefore warned when motor overload occurs and can then readjust the turbine governor speed changer to take on more load.

PROTECTION for the 4000-hp motor is provided by various relays located in the switchgear. Included are: differential relays for protecting the motor windings; current balance relay for single phasing protection and unbalanced line currents; ground relay for excessive ground currents; thermal relay to

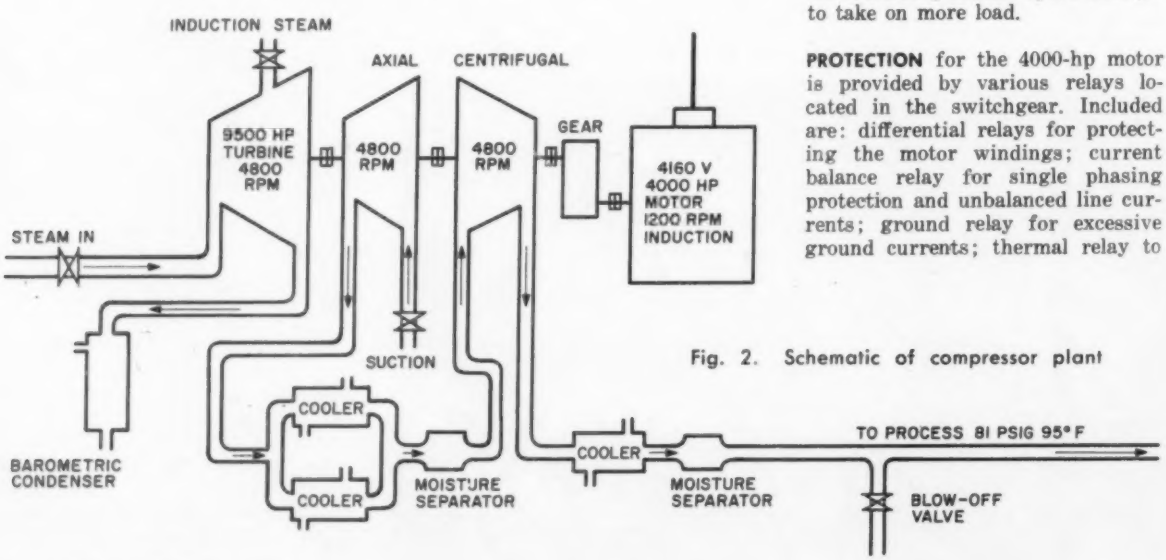
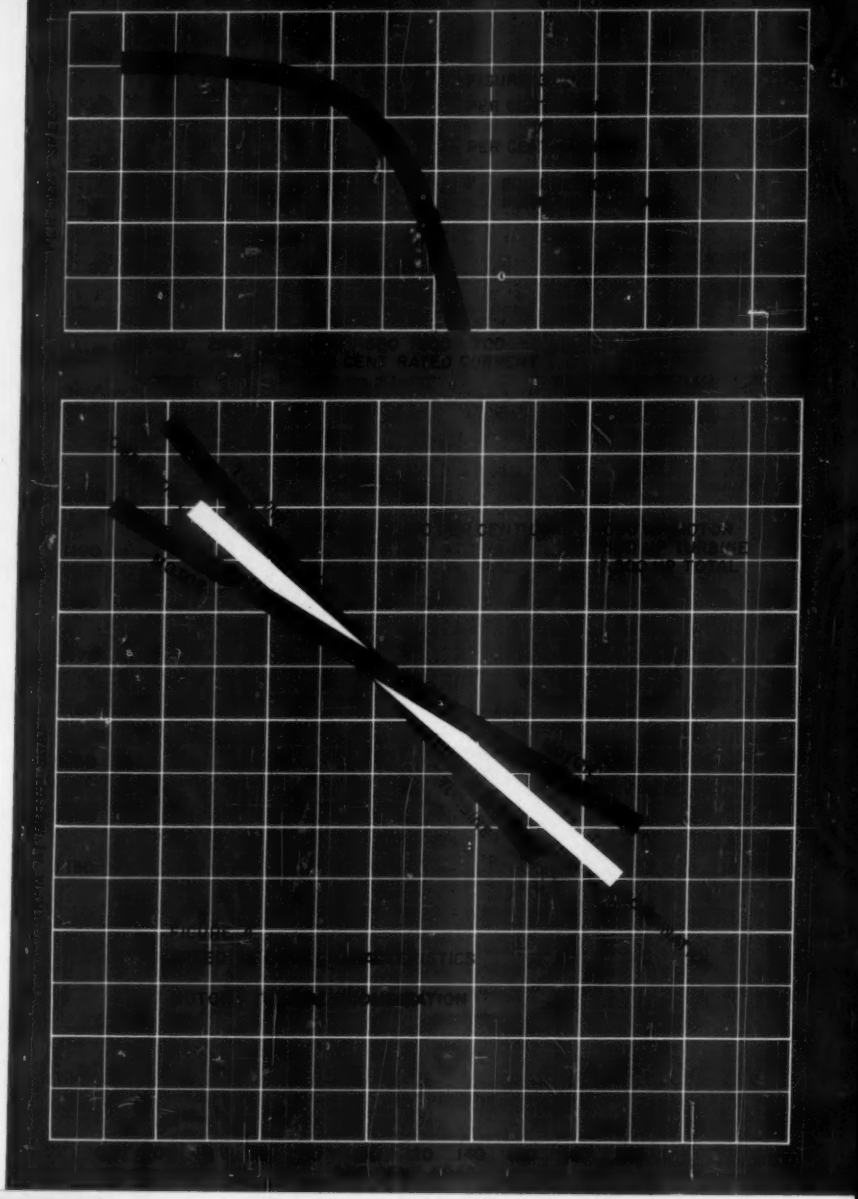


Fig. 2. Schematic of compressor plant

protect against stator winding overheating; time and instantaneous overcurrent relay for overcurrent protection; and undervoltage and phase sequence relays. Operation of any of these relays will trip the motor circuit breaker. Control power is monitored by an undervoltage relay.

A combined lubrication system supplies 150 SSU at 100 F oil to the compressors, turbine, and motor bearings as well as the turbine governor system. Likewise, it supplies the high-pressure oil necessary for hydraulic operation of the power cylinders for the adjustable stator vanes, suction and blow-off valve positioners. Because a heavier oil is preferred for the gear and the oil spray must be at a higher pressure than bearing oil, it was provided with a separate lube system.

THIS AXIAL-CENTRIFUGAL arrangement has proved itself to be an extremely efficient and flexible system requiring almost no maintenance since it was installed approximately two years ago. Although the majority of the on-site oxygen plants built to date have been of the smaller tonnage size outside of the axial-centrifugal range, the demand for all forms of oxygen, nitrogen, and related gases for many industries is increasing. Experts predict that the total annual, oxygen tonnage will increase threefold by 1965, with consumption in the chemical industry alone expected to double by 1966. Larger on-site plants are inevitable and this means more and more axial-centrifugal compressor combinations if lowest possible generating costs are desired. END



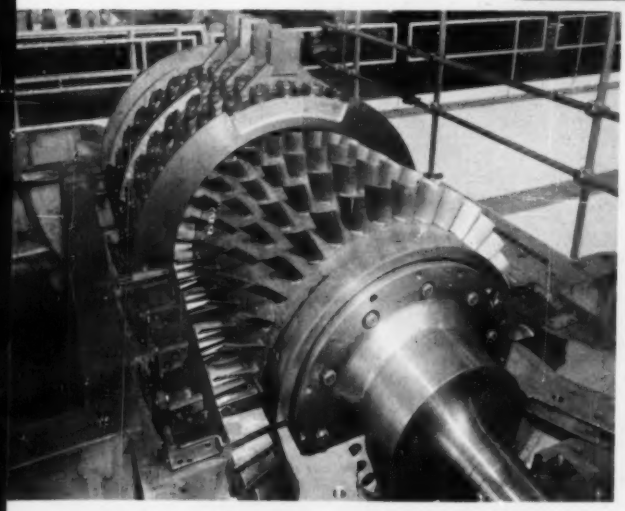
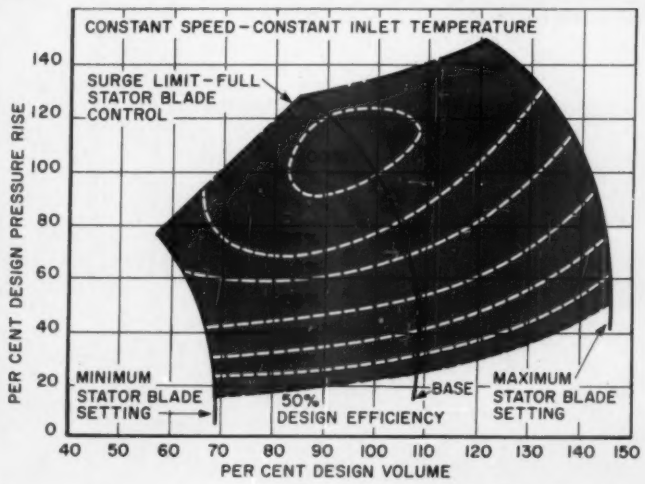


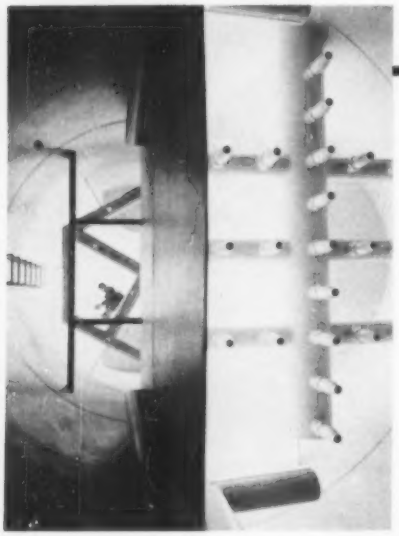
Fig. 5. These levers regulate blade positions on axial compressors. Figure 6 shows expected performance

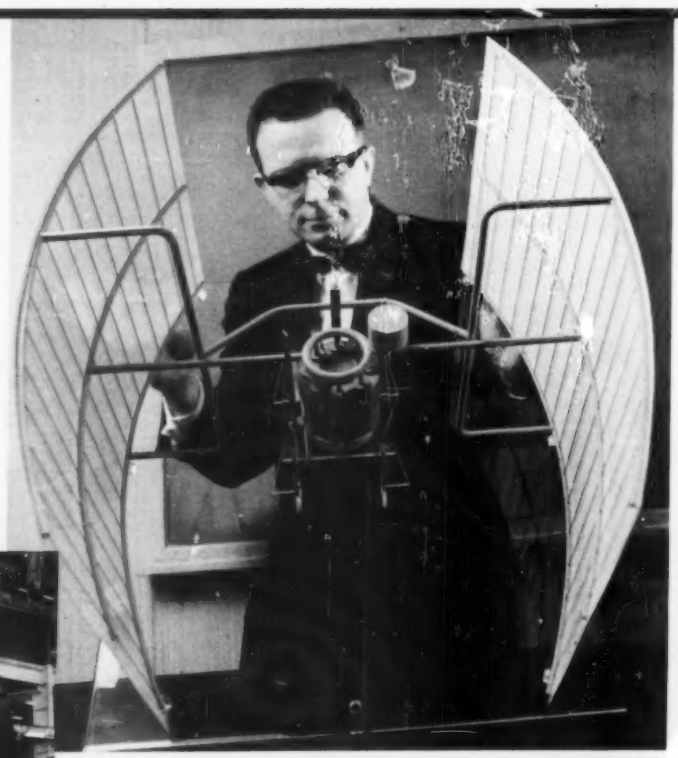


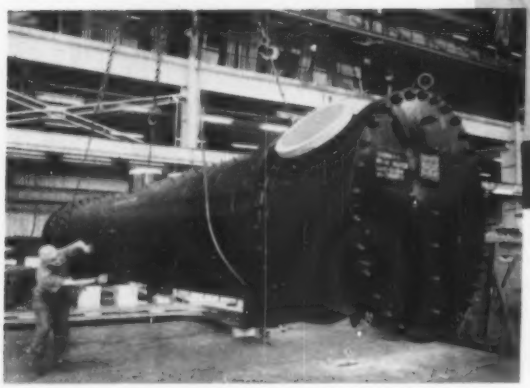
President Kennedy meets with members of SBME. Dick Morris of Power Engineering is at the President's right

Power Engineering's

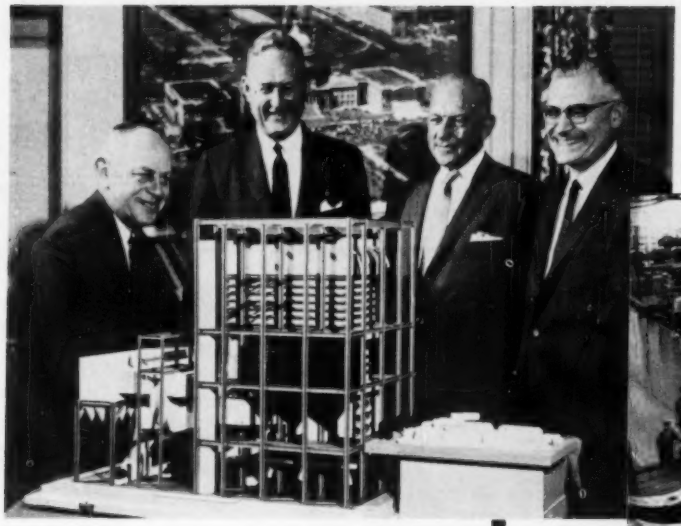
Inside direct contact air condenser made by Southwest Engineering Co. for NASA research



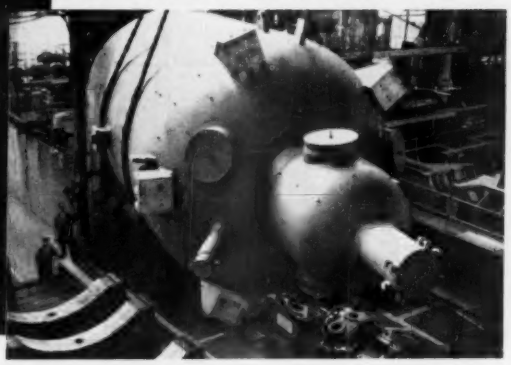




Nuclear thermoelectric power package (model above) developed by Westinghouse for space, moon, other uses. **Left:** 19-ft long brine heater bound from Westinghouse for seawater desalting plant at Point Loma, California

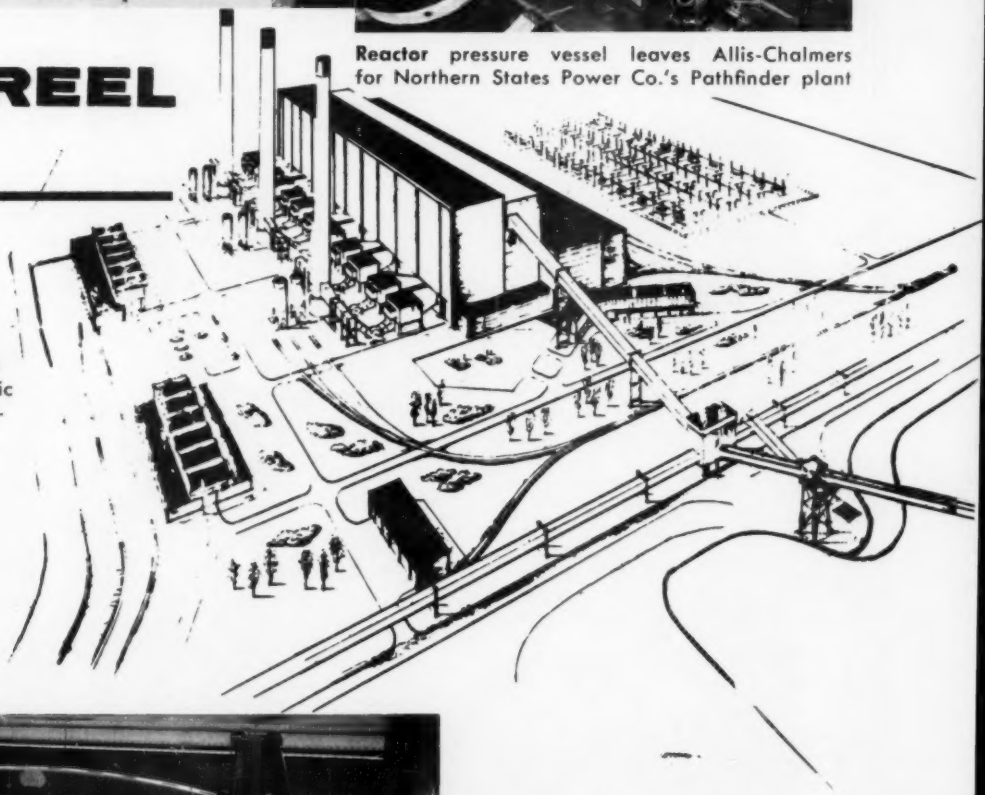


Chalk Point Station of Potomac Electric Power Co. is a $105-million plant to be completed in 1965. Viewing model are R. Roy Dunn, Pepco president; S. T. Mackenzie of Babcock & Wilcox; Geo. Bissett and L. W. Cadwallader

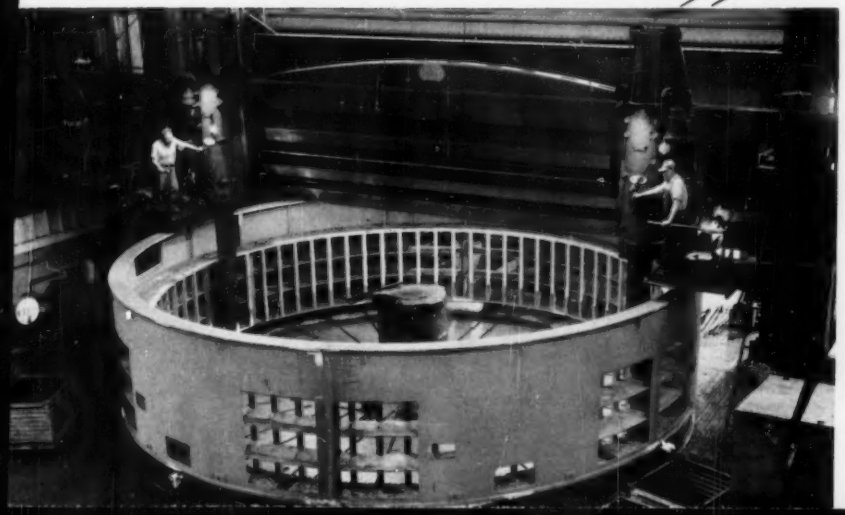


Reactor pressure vessel leaves Allis-Chalmers for Northern States Power Co.'s Pathfinder plant

NEWS REEL



Ontario Hydro's huge Lakeview steam-electric plant will have capacity of 1,800,000 kw



Vertical synchronous generator stator being machined at Allis-Chalmers is 34 ft in diameter, nearly 6 ft high and weighs about 57 tons. It's for a reversible pump-turbine at Appalachian Power Co.'s Smith Mountain project in Virginia

MILLION ANNUAL RADIO CALLS ROUTINE TO CONSUMERS POWER

John Miller, General Communications Supervisor, Electric Operations, shows radio's increased value

TWO-WAY RADIO blankets 29,000 sq miles of Michigan's Lower Peninsula with 54 base stations and 1190 mobile units which handle over one million calls annually. It helps bring better service to electric and gas customers in 331 cities and villages, 799 townships and 512 unincorporated communities—about half of the state's population in all. The communications network is tied in with system electric generating plants, transmission lines, substations, natural gas storage fields, gas supply lines and gas distribution.

First consideration of the company is to provide the quickest and most reliable service to its customers. Many routine calls such as turn-ons and turn-offs in either the gas or electric operations are dis-

patched daily, except for emergency calls of gas leaks or electric interruptions which take priority over the routine orders.

Five frequencies in the 47 mc (low) band handle traffic from the Electric Operating and Gas Operating departments. The frequencies are close enough together to be handled by a standardized mobile antenna, but separated enough so gas and electric emergencies can be handled simultaneously.

Under Electric Operations are the Bulk Power and Electric Distribution sections. Bulk Power operates and maintains all 138-kv lines, and switches and controls power over lines of 22 kv and above. It also is responsible for all electric generation on the integrated system. Electric Distribution operates all lines less than 138 kv, and is responsible for customer electric and appliance service.

Bulk Power uses ten base stations and 50 mobiles to cover the entire service area (see map) in four regions. Each region's dispatching center handles all switching orders, pre-arranged interruptions and dispatching of Bulk Power supervisors. The main dispatching center at the General Office in Jackson is in direct wire and radio contact with all regions. Bulk Power's mobile radio system is the simplex type, wherein the dispatcher talks to the car on Frequency A and the car replies on Frequency A. Car-to-car communications are possible here, too.

USING DUPLEX. Electric Distribution operates on a duplex (two frequency) basis in 36 areas on Frequencies B and C. The base station in each area transmits on Frequency B and receives on Frequency C. Thus, the 665 mobile units associated with these stations transmit on Frequency C and receive on Frequency B. Because of the duplex operation, normally, car-to-car transmission and reception is not realized.

Since it is desirable on the duplex system to have certain area foremen and supervisors' cars talk to other cars in the area, their cars are equipped with a switch that allows them to transmit on Frequency B and receive on Frequency C. Thus, they can talk to any other Electrical Distribution cars within radio range.

Also, some key personnel cars are still further equipped with Frequency A for transmitting and receiving on the Bulk Power network. Thus, Electric Operation sections are compatible with each other.

The Gas Operations department is responsible for all subtransmission gas lines and the gas distribution system in its 23 areas. Some of these are coincidental with electric areas. This operation's 23 base stations and 475 mobile units handle Gas Distribution calls like reported gas leaks, appliance service and other troubles.

Presently, the smaller combination gas and electric areas operate over the same frequencies (B and C) with separate control points located in the same general headquarters.

As radio traffic grows, it becomes necessary to separate the gas and electric operations frequencywise. Therefore, Frequencies D and E (duplex) are employed entirely for gas operations. During emergencies occurring on both gas and electric systems, these additional frequencies allow both departments to be on the air simultaneously to take care of the trouble faster than otherwise possible.

Bulk Power base station transmitters and receivers usually operate from a 200-ft steel tower in a preferred location. They transmit at 250 watts to cover the four large regions.

The 41 electric and/or gas operating areas require less coverage. Therefore, overlaps between the areas on communications networks can be kept to a minimum by lower antennas and lower power. Antenna supports for these base stations usually consist of 65 to 85-ft wood poles placed in strategic locations and not always directly at the service center. Output on electric and gas base stations is usually 50 watts.

Standarized 8 by 8-ft steel buildings are provided whenever the radio equipment is remote from control centers and utilize a leased voice and control circuit to the headquarters console or consoles. When the service center is in a desirable location, the equipment is often installed in the service building with the antenna mast erected on the roof.

Formerly, the radio system was leased from Michigan Bell Telephone Co. Recently, consumers executed a contract with the Radio Corporation of America in which RCA purchased existing equipment and is to provide the service and maintenance for the entire system.

SELECTIVE SIGNALING was chosen about two years ago to provide better service and to utilize routine gas trouble-men for other purposes. Selective signaling was tried in ten gas units in one area to determine the economics and efficiency of these installations. The type of selective signaling was carefully chosen for trial so, in the future if necessary, the same scheme might be employed that would be compatible in all areas for a maximum of 1000 units.

Since all vehicles have assigned four digits or less as a car number for all company records, and all voice calling is performed by car number, a dial calling system was chosen. The manufacturer provided the necessary modifications so that regular four digit or less car numbers could be dialed directly without using any other code numbers, etc. Thus any base station, so equipped, can call any car from other area cars called in on emergencies, when so equipped, or directly by voice calling.

This system—although more expensive—has proved its worth over the two-year test period and is now being extended to other gas areas in certain trouble cars where it is justified. Wholesale installations are not considered economical at this time for all units.

With this calling system, gas servicemen, on routine (following regular work-hour calls), are available immediately for emergency calls.

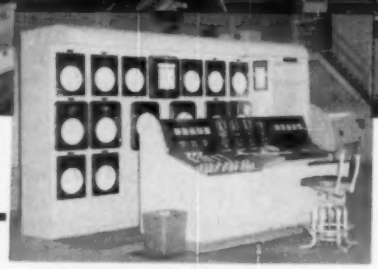
When a car is dialed, its receiver activates the car horn for three seconds and lights a flashing red light on the vehicle which remains flashing until the driver reports in.

During normal traveling time, the serviceman can switch off the horn and light activator and can still be called by selective signaling or voice without disturbing other vehicle traffic.

ACTION DURING CRISES. Many times in emergencies consisting of lightning storms, sleet storms, mild hurricanes or tornadoes, gas explosions or fires unrelated to the company, cars are dispatched immediately to the stricken area to provide the best possible service to the customer.

In major catastrophes of any kind, large numbers of crews, either gas or electric, can be and are moved into the catastrophe areas for the quickest possible restoration of service.

As Consumers President James H. Campbell says, "A modern dependable communication system is an absolute necessity if we are to accommodate properly a constantly growing number of gas and electricity users in Michigan's urban and rural areas." END



POWER FOR A PAPER MILL

A. E. Teschendorf of Rhinelander Paper Co. describes the plant for this large power consumer

RHINELANDER Paper Company, a division of St. Regis Paper Co., manufactures glassine and greaseproof papers which are used primarily in the food-packaging fields where a high degree of oil or grease resistance is necessary for product protection.

Power requirements per ton of finished paper are generally higher for these types than for other papers because of the high degree of pulp refining necessary. In addition to the high power requirements, the nature of pulp preparation using the calcium bisulfite process precludes using the digesting liquor as a recovery fuel. Thus, all of the steam generated must come from primary fuel sources.

Electricity, steam, water and air are all consumed in large quantities. Electrical demand averages 18,000 to 19,000 kw with a maximum of about 24,000 kw in winter. Steam flow averages 420,000 lb per hr in winter, 320,000 lb per hr in summer. Big difference between winter and summer use is due to large volumes of ventilating air and cold river process water which must be heated in the winter. Total water use averages 31 million gallons per day, and air requirements are about 2,246,000 cu ft per day.

These demands are reliably met by a completely independent power plant. The possibility of tying in with the utility was investigated, but the cost of standby power was considered too high.

Steam is supplied by five underfeed stokers and a recently installed cyclone-furnace boiler. Each underfeed stoker is rated 80,000 lb per hr at 400 psi and 680 F. An Eastern coal was formerly burned in these units; a Midwestern low fusion coal, required for the cyclone furnace, is now being used with good results.

Ash from the stokers is crushed after leaving the grates and dumped into a hopper where it is quenched. Trucks remove the ashes three times a week.

From the bottom of the cyclone furnace the slag runs into a quenching tank. A hydraulic jetting system removes the slag from this tank to an outdoor elevated storage hopper, from which it also is removed three times a week by truck.

When the boiler was first put in operation, the flyash was recirculated in an attempt to obtain more complete combustion. This apparently

Left: Aerial view of Rhinelander Paper Co. at Rhinelander, Wisconsin, where Mr. Teschendorf is the assistant chief engineer. Inset: Turbine control panel with turbine-generator in background

had a negligible effect on combustion efficiency, but enormously increased the eduction of flyash from the stack and also complicated the housekeeping problem due to leakage of flyash at various points. Flyash is now accumulated in hoppers located before the air heater. From here it is removed by a hydraulic jetting system to the same storage hopper used for the slag. This method is rather unconventional, but has operated quite satisfactorily using a plant-engineered system. A permanent installation has now been contracted for, based on this successful test.

IMPORTANT CONSIDERATIONS. In deciding on steam conditions and furnace type for the new boiler, main emphasis was on reliability and cost of fuel. Pressure had to be high enough to supply a 7500-kw topping turbine with extraction at 400 psi and exhaust at 125 psi. It was decided that the B & W cyclone-fired steam generator with outlet conditions of 1500 psi 950 F was the best answer. This was a proved design with many successful installations. Boiler's rating is 250,000 lb/hr.

Bark is burned in an old hog fuel boiler, but the output is so small that this is practically an incinerator. Plans are being made to burn the bark in the underfeed stokers to obtain a more efficient use of the bark.

Electrical supply is from three steam turbine-generators and three hydraulic turbine-generators.

Topping turbine, which is rated 7500 kw, drives a generator rated at 11,500 kva, 12,500 v. A 12,500-kw condensing unit takes steam at 400 psi and extracts at 125 psi. This drives a 13,500-kva, 12,500-v generator. A 5000-kw unit drives a 480-volt, 5000-kva generator which supplies the 12,500-volt bus through a tie transformer. The turbine extracts to the 15-lb line and exhausts to a hot water heater which acts as a high-temperature condenser. Hydro plant is rated 2100 kw, 480 volt. Hydro bus feeds high-voltage system through a tie transformer. Part of the load can be carried directly from the hydro board, so that a failure in the steam system will not shut down the entire plant.

Distribution is from ten substations which range from 1000 to 3750 kva. The largest unit is oil cooled; all others are air cooled. Three stations supply 2300-volt motors, while the other seven step down to 480 volts.

A converting plant located about a mile and a half from the mill is supplied by a pair of oil-cooled 750-kva substations. Voltage is stepped up from 480 to 4150 for transmission and then back down to 480.

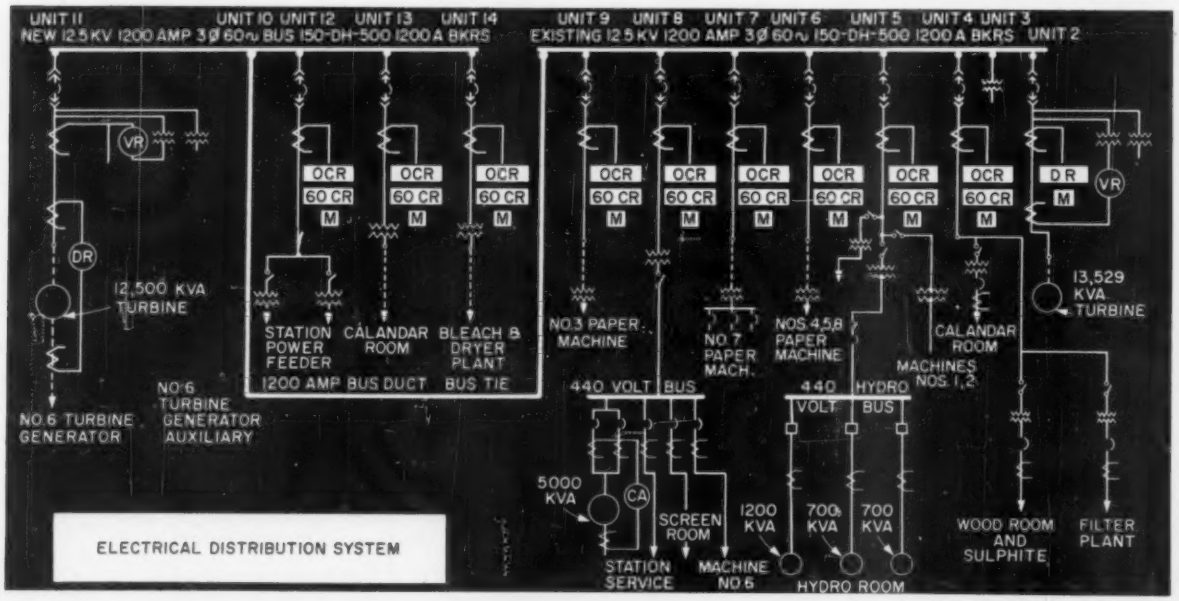
Boiler water make-up averages about 50 per cent because of the large process-steam demands with no return. A 300,000-gallon per day Infilco system supplies this demand, with river water as the make-up source. The system consists of an Accelator and clearwell, pressure filters, anion and cation exchangers, and a degasifier. Filming amine treatment is used for the entire steam system.

WATER TREATMENT. For process use about 28,000,000 gallons of water per day are chemically treated. This involves a floc tank, settling tank, chlorine addition, and filtering through anthrafilt and sand. Approximately 3 million gallons per day of raw river water are used for cooling, and flushing and diluting of wastes.

Compressed air is supplied at an operating pressure of 100 psi by one steam- and three motor-driven compressors, plus one instrument air compressor for emergencies. Synchronous motor-driven compressors are rated 1300 cfm, 500 cfm, and 500 cfm. Steam engine-driven compressor, used for standby, is rated 550 cfm. END

List of Major Equipment and Manufacturers

Generators & turbines: Westinghouse. Hydro units: Leffer turbines, E & M generators. **Boilers**—Underfeed stokers: American Engineering stoker, Babcock & Wilcox boiler; cyclone furnace: B & W. Consulting firm is Pfeifer & Shultz. Combustion control system: Bailey. Oxygen analyzer: Leeds and Northrup. Coal handling system: Fairfield Engineering. **Ash disposal system**—Hoppers and quenching tank: Allen-Sherman Hoff; hydraulic jetting systems: United Conveyor. **Air compressors**—Motor driven and steam engine driven: Ingersoll Rand; instrument air: Gardner-Denver. **Water treatment**—Boiler water: Infilco; process water: designed by Rhinelander Paper Co. **Substations**—Transformers and switchgear: Westinghouse; control center: Westinghouse and G. E.



NEW SYSTEM FOR EXCITATION

D. B. Hoover of Westinghouse describes a system which eliminates commutators, collectors, generator field breakers, shunt field rheostats, spare exciters

SIMPLIFIED SKETCH of Fig. 2 shows the basic components of a new system for excitation for electric utility generators. It is called "brushless excitation." Reliability, maintenance and performance are improved; at the same time installation cost is reduced.

External leads between the exciter and the generator field are not required. Small external connection leads are only necessary for the stationary pilot exciter armature, the stationary a-c exciter field and for control leads.

Number of diodes and fuses is determined by the rating of the exciter and the type of rectifier circuit. In some cases there will be more than one diode in series in each path. In this case voltage division is secured by high-resistance, low-wattage resistors connected across each diode.

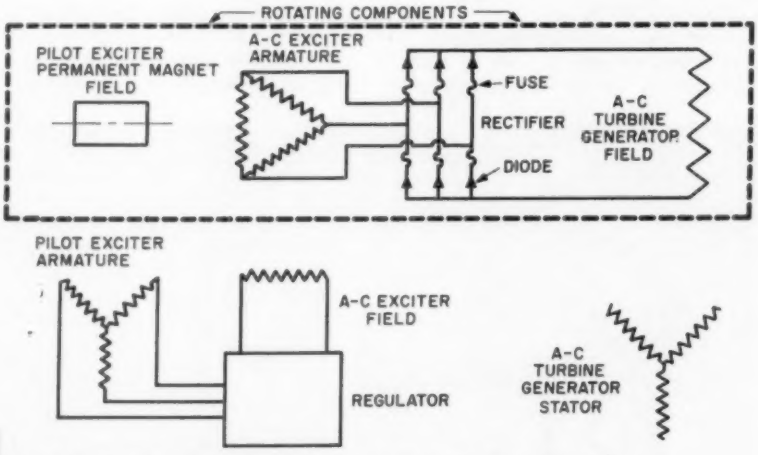
The high-frequency permanent magnet generator (420 cps) provides power to the Magamp-type voltage regulator which in turn energizes the field of the a-c exciter. Output of the a-c exciter is rectified by silicon diodes and fed into the field of the a-c generator. The system is protected against diode failure by series-connected fuses with indicators to show when they have blown. These devices may be viewed during operation by the use of a Strobo-Tac. The components of this system are applied on the basis that continuous conservative operation is achieved with only 80 per cent of the diodes per phase in operation. The exciter need not be shut down until the 80 per cent point is reached and even so, the use of the Strobo-Tac permits this to be a planned shutdown.

The excitation system is designed to operate successfully through any transient conditions imposed by the a-c generator. This includes operation at ceiling voltage for one minute with only 80 per cent of the diodes in operation during these conditions.

The entire exciter will normally be totally enclosed and self-ventilated. An air-to-water heat exchanger will be used to cool the ventilating air. Use of this ventilation arrangement results in an extremely simple foundation as all of the exciter components are contained in the exciter housing above the floor. This arrangement results in an exciter which operates quietly.

FIVE PRINCIPLES of regulator design have been followed in the development of this excitation system. The system must: 1. be continuously acting, 2. have fast response, 3. be easy to stabilize, 4. have reliable components, and 5. have a good excitation limiter.

Continuous action without dead band is made possible by utilizing closed-loop feedback circuitry. Referring to Fig. 3, a three-phase rectified voltage intelligence is taken from the machine terminals through potential transformers, and compared with a constant reference quantity in the first stage of magnetic amplification. The difference becomes the "error control signal." This signal is further amplified through an additional stage for con-



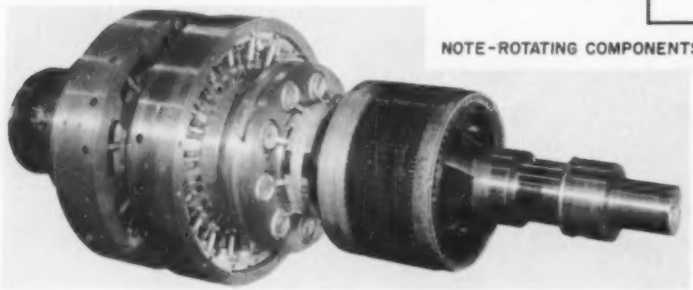


Fig. 1 (left). Rotating element of a rotating rectifier exciter. Fig. 2 illustrates a typical rotating rectifier excitation system. Fig. 3 (opposite page). Schematic illustration of regulator components with the brushless excitation system

trol of the power magnetic amplifier, which excites the field of the a-c rotating exciter. The regulating loop is sequentially closed through the a-c exciter, the rotating rectifier, the turbine-generator field and the turbine-generator stator.

Fast response is accomplished by designing the components within the closed-loop circuitry to have very short time delays. In fact, the time delays obtained are so short in comparison to the generator time constant that the feedback system reduces to essentially a "single delay" system. These short delays are made possible by utilization of 420-cps brushless rotating power units for the a-c exciter and pmg.

Low-power intelligence circuitry coupled with the essentially single delay feedback system makes circuit stabilization simple and easy.

The resulting system is made exceptionally reliable by the use of static magnetic-amplifier circuitry and the brushless, slip-ringless permanent magnet power source.

REGULATING EQUIPMENT is designed as functional component panels (Fig. 3). A regular panel comprises the intelligence circuit, the reference circuit and the first stage of amplification whose output is the error control signal. An amplifier panel provides the second stage of amplification and the auctioneering circuitry which "sells" control of this stage to the higher bidder, be it the regulator panel output or the limiter panel output. This panel also contains the regulated bias supply for these magnetic amplifiers.

A limiter panel provides circuitry for an ideal minimum excitation limit. A damping panel provides the necessary feedback elements for circuit stability.

ADVANTAGES of this system are:

1. The rotating rectifier excitation system derives all of its power (including excitation) from the shaft of the main generator—insuring a very reliable system.
2. Since there are no collector or commutator brushes, carbon dust is eliminated. The absence of carbon dust lengthens the time between required cleanings and lessens the possibility of low insulation resistance to ground.
3. The system is not affected by atmosphere contamination since all of the components are sealed. This is a major advantage over the present operation of carbon brushes in contaminated air.
4. Cost of brush replacement and maintenance is eliminated.
5. Collector and commutator maintenance is eliminated.
6. The 20 per cent spare capacity built into the excitation system eliminates the need for a spare exciter.
7. Eliminated are shunt field rheostat, a-c generator field breaker, main lead bus wiring between exciter and a-c generator field, large foundation openings for ventilation and main leads.
8. Simplified maintenance requirements and foundation.

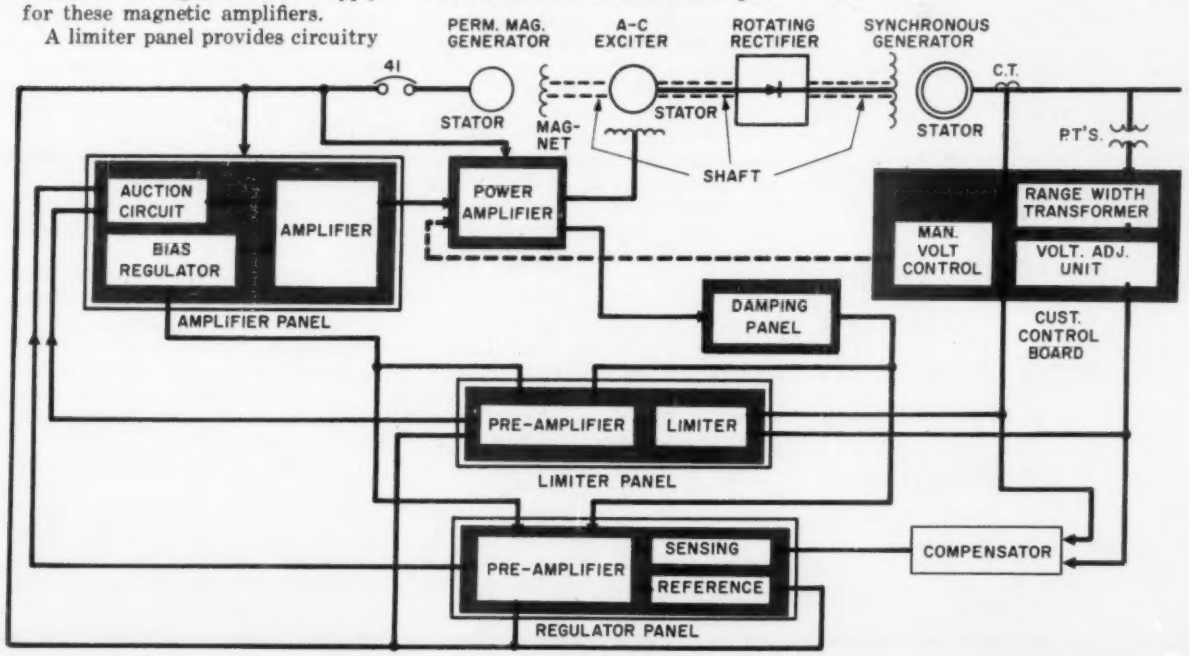
ROTOR of an 180-kw 250-v rotating rectifier exciter is shown in Fig. 1. This unit was installed on the customer's property in March 1960. The only shutdown was to correct some bearing trouble. Maintenance has been practically eliminated since there are no brushes, commutators, collectors or carbon dust. Maintenance consists of changing air filters and an occasional blowing out with air.

It should be noted that this particular unit is not totally enclosed since it was designed to replace an old conventional d-c exciter and was designed to use the existing foundation, ventilating openings, etc. Future units will be totally enclosed and will not require as much filter maintenance.

One diode shorted during this period of time and was replaced. There are two diodes in series in each path, so even though one diode had shorted, the path still functioned in a normal manner and the fuse had not blown. Another diode was found to have somewhat more than normal leakage current and was replaced even though it was still operable.

This exciter has now operated for well over a year and is proving the reliability and low maintenance of this type of excitation system.

A 1350-kw 375-v brushless excitation system is being built and will soon be tested and installed as the excitation system for a large generator. This brushless exciter will require less space than the conventional d-c exciter, gear and collector. This will be true of other brushless exciters. END



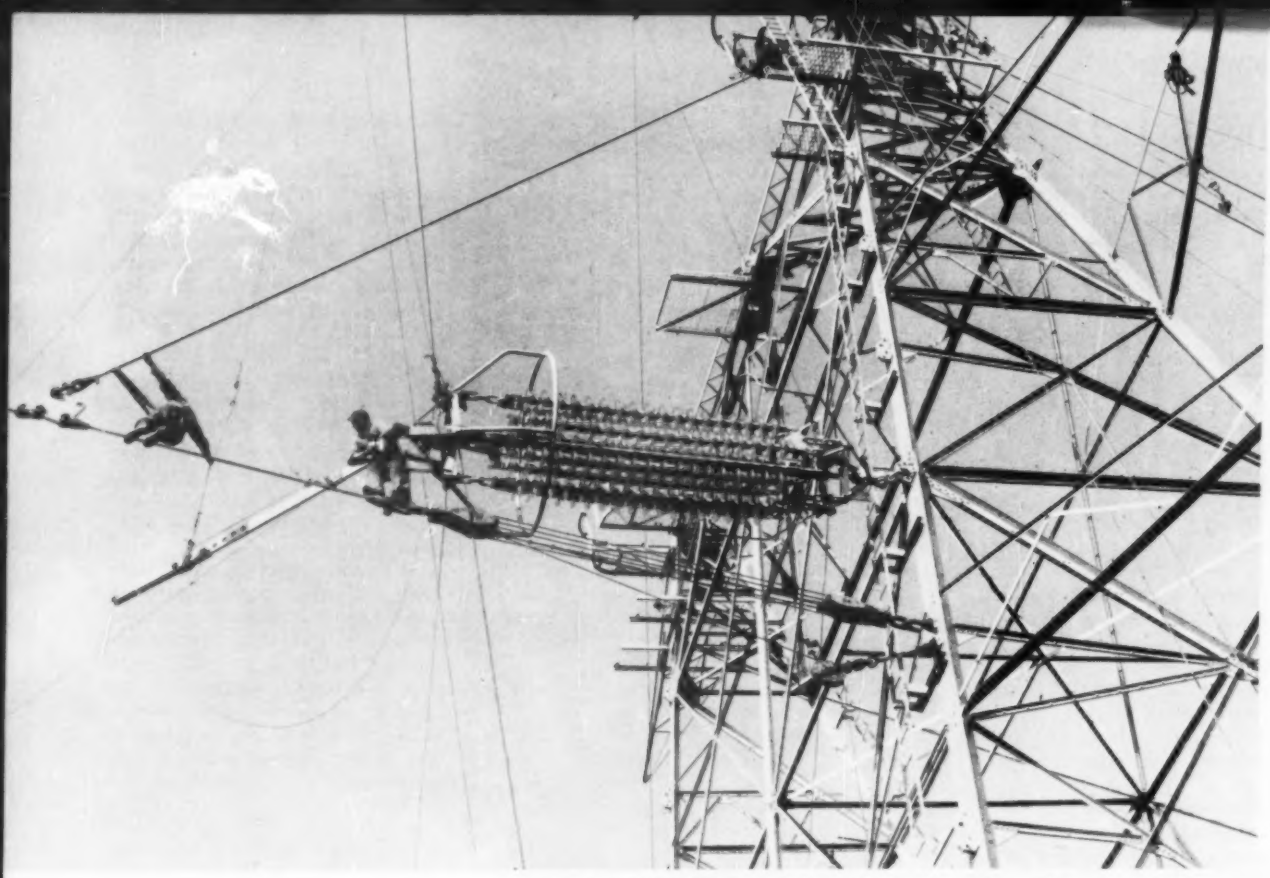


Fig. 1. Conductor brought to final dead-end position

EHV RIVER CROSSING

Paul Grudko, Chief Engineer of J. L. Eve Construction Co, describes design and erection of EHV line in England

A SERIES OF EHV river estuary crossings is now in process in Great Britain. Latest completed was the double-circuit 275-kv line over the River Usk in South Wales.

Eiffelised crossing towers mount 394 ft above water. Both are 62-ft square at the base and 8-ft square at the top. The first 45 ft is in boxed laced sections 2 ft 2 in. square. Requiring no secondary bracing, the boxed sections proved to be more economical, and also an advantage to the erector, being self-supporting cantilevers on the whole length of the member. Upper portion of the tower has cruciform section legs of four angles and, generally, diamond-shaped bracing of double or single angles.

On top, a transverse platform, 8-ft wide and 64-ft long, has a rail to carry a pilot carriage. At each end and in the middle of the platform, longitudinal cantilever platforms 26-ft long were used during conductor erection (see Fig. 2).

Anchor towers 100-ft high consist of two A-frames 42 ft apart, connected with wind bracing. Superstructures with platform for conductor erection were built on top. Legs and most of the bracings are of double-angle, back-to-back sections. Bottom panel bracings are of two angles, 15 in. apart, diagonally laced.

Piled foundations were used because of soil conditions. Datum of tower bases at the West bank is below the high tide water level. Concrete caps up to 12-ft deep were cast atop the piles. All tower legs are anchor-bolted to the foundations.

A specially designed floating derrick, weighing five tons, helped erect the first 200 ft of crossing towers. A light tubular floating derrick erected the upper portion.

West span (over land) is 1476 ft; River span, 2785 ft; and East span, 1442 ft.

To carry conductors across the river, a special 1.25-in.-diam 6000-ft-long steel pilot cable was manufactured by British Ropes, Ltd. Its end was taken over a sheave on top of the West anchor tower and connected to a tackle fixed to a concrete anchor block behind it.

A barge towed the remaining 4500 ft of pilot cable across the river bed. From the barge, the cable was flaked on the ground close to the East crossing tower until the end socket was recovered from the drum. Then

it was winched over sheaves on the East crossing and anchor towers and connected to tackle similar to that on the West side.

A statimeter on the tackle fall checked cable tension.

HAULING ROPE ERECTION. From a winch containing 6500 ft of rope and placed beyond the West anchor tower, the rope was pulled over a sheave on top of the anchor tower and along the pilot cable. It rode on little pulleys clipped to the rope and set on the pilot. Actual pulling was from the tractor along the ground and from the launch across the river.

A second five-ton winch with 6500 ft of rope was placed beyond the East anchor tower. The rope was pulled along the pilot and taken over the East crossing tower top sheave to ground. The two ends, spliced, formed a 13,000-ft-long rope. The hauling rope was pulled back from the winch at West anchor tower. Erection pulleys were removed and spacers at 240 ft clipped to the hauling rope.

Communication during the stringing operation was by radio. Once the first conductor was strung, field telephones installed at top and bottom of each tower supplemented the radios.

CONDUCTOR ERECTION. The 15-ton conductor drum's axles were mounted on a telescopic stand bolted to a concrete base. A special bogie on huge casters shifted the drum. Hydraulic jacks lifted the drum off the bogie.

Conductors were supplied cut to length with dead-end clamps already fitted. They are 78/0.113 in. aluminum over 91/0.113 in. steel and are 1.695 inches in diameter.

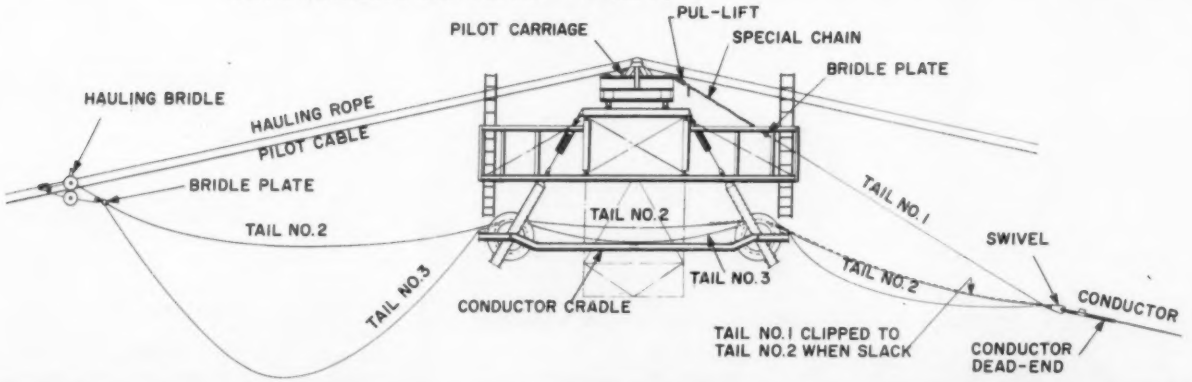
Conductor dead-end was lifted from anchor tower outriggers, passed through a 36-in.-diam sheave nine ft below the pilot cable on the tower superstructure, and connected to a bullet-shaped swivel. The swivel's front end held a socket containing three 7/16-in.-diam tail ropes — 40 ft, 100 ft and 160 ft long. These were connected to a bridle which consisted of two sheaves on the pilot. One sheave was a runner, the other a guard. The bridle was clipped to the hauling rope.

Stringing tension was first taken by the 40-ft. tail, No. 1. Nos. 2 and 3 sagged slack (see Fig. 3). It was controlled between 1100 and 1700 lb by a hand brake on the drum stand.

Suspenders were clipped every 120 ft; the hauling bond was clearly marked. Distance between upper and lower suspender sheaves was two ft greater than that between pilot and conductor at the tower center line—11 ft. This made placing of conductor in the sheave easy. When the hauling bridle reached the first crossing tower, tension in tail No. 1 was transferred from the bridle to the pilot carriage by means of a Pul-lift. Now, with conductor dead-end being held by the tower, the hauling bridle could be taken off the pilot and placed on the other side of the tower. Ropes 2 and 3 were threaded through the cradle and fixed to the bridle (see Fig. 3). Hauling rope was set in motion, and tail No. 2 took the ten-

Fig. 2. Each crossing tower has a working platform

Fig. 3. As conductor reaches East crossing tower, tension is transferred from Tail No. 1 to Tail No. 2



sion, releasing the Pul-lift. Suspenders were unclipped and transferred to the tower's other side.

When the conductor reached the second crossing tower, tail rope No. 3 took the tension.

When the conductor was off the drum at the East anchor tower, the dead-end was held by a winch rope connected to the dead-end with a bolted clamp. After passing through the tower, the dead-end was connected to the dead-end with a bolted clamp. After passing through the tower, the dead-end was connected to a square plate with four holes. The plate held a tension rope and "step down" tackle for final connection to the tension insulator dead-end sets.

The hauling rope was pulled until the other dead-end was within reach from the West anchor tower. Figure 4 shows four-hole plate hook-up which is similar to that on the East anchor tower.

Simultaneous operation of tensioning tackle winches on both ends of the crossing tensioned conductor out of suspenders, leaving bottom sheave two ft below. Then the cradles on crossing towers with the conductor were lowered and suspended on the set-length pennants under the bottom crossarm.

To prevent the conductor being caught back into the sheaves, suspenders had lead-weighted flaps covering the grooves. Then dead-ends were winched down to receive tension sets (see Fig. 1).

Tension sets consist of eight 18-unit strings and are 21.75 ft long. If one string breaks, the yokes tilt, distributing load uniformly between the remaining seven strings. A 20-ton capability jacking strut inserted inside the insulator made the assembly rigid enough for lifting in a horizontal position.

Fourteen aluminum armor rods, ½-in.-diam tapered to ¾-in.-diam, were twisted on from the cradle platform.

After suspension set erection, the conductor was lifted slightly on the cradles to insert 6-ft-long saddles. Conductor is not clipped to saddles. The cradles then were lifted into running-out position for the second conductor.

Before erection of the second conductor the hauling rope was pulled back and all suspenders returned to the East anchor tower. Behind suspenders, the spacers were clipped at 240 ft to the hauling rope. The spacers were made as a replica of top half suspenders with the weight at the bottom end and were required to prevent the hauling rope from surging and dropping on the conductor already erected or even below river clearance at the beginning of the conductor's running out, when required tension is small.

STATIC WIRE ERECTION. Pilot was shifted into the middle of the crossing towers and remained above the second circuit at the anchor towers. The cradle strut was inside the tower body in final position of the static wire. Static wire landing was done with two tackles attached to a square plate and two lugs 1 ft 6 in. each side of the final attachment point.

During conductor running, maximum hauling rope load reached two tons. Pilot tension varied from 20 to 36 tons.

Pilot cable removal was more difficult than erection, having seven conductors on the way down. It was dropped into the river and on the ground in reverse to the method of erection. Two six-ton winches, with their ropes bridled in compensating arrangement, pulled the pilot from the East side.

Stringing time per conductor averaged 12 hours. Hauling speed varied from 40 to 60 ft per minute All seven conductors were erected in eight weeks, of which two weeks were of rainy or gale weather and no work could be done.

The job took 16 men, two foremen and one resident engineer. END

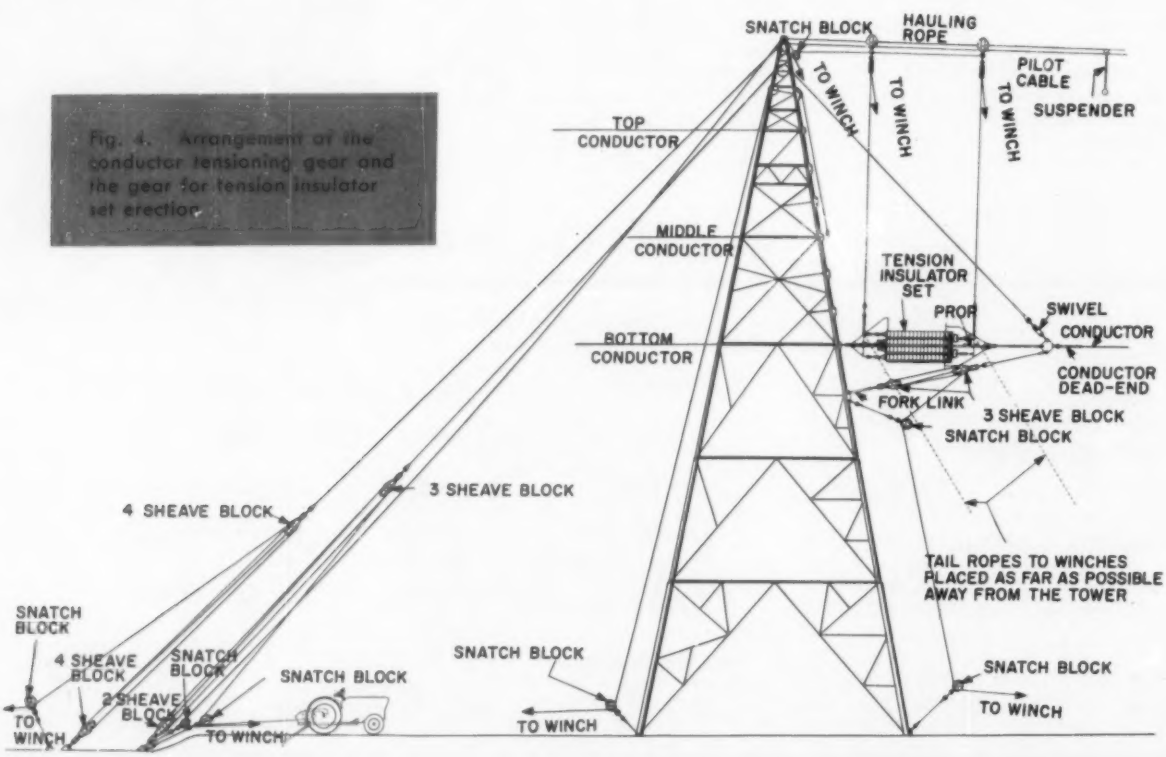


Fig. 4. Arrangement of the conductor tensioning gear and the gear for tension insulator set erection

FALL GENERAL MEETING IN DETROIT

ELECTRICAL ENGINEERS from all facets of industry and utilities converged on the Motor City recently, and discussed subjects ranging from Outer Space Communications to Safety in Swimming Pools.

President W. H. Chase addressed the entire delegation at the General Session; Detroit's Mayor, L. C. Mariani, gave a hearty welcome; and the main speaker was Mr. George E. Gullen of American Motors Corp. (Mr. George Romney, president of AMC, had been scheduled but was forced to change his plans at a late moment.)

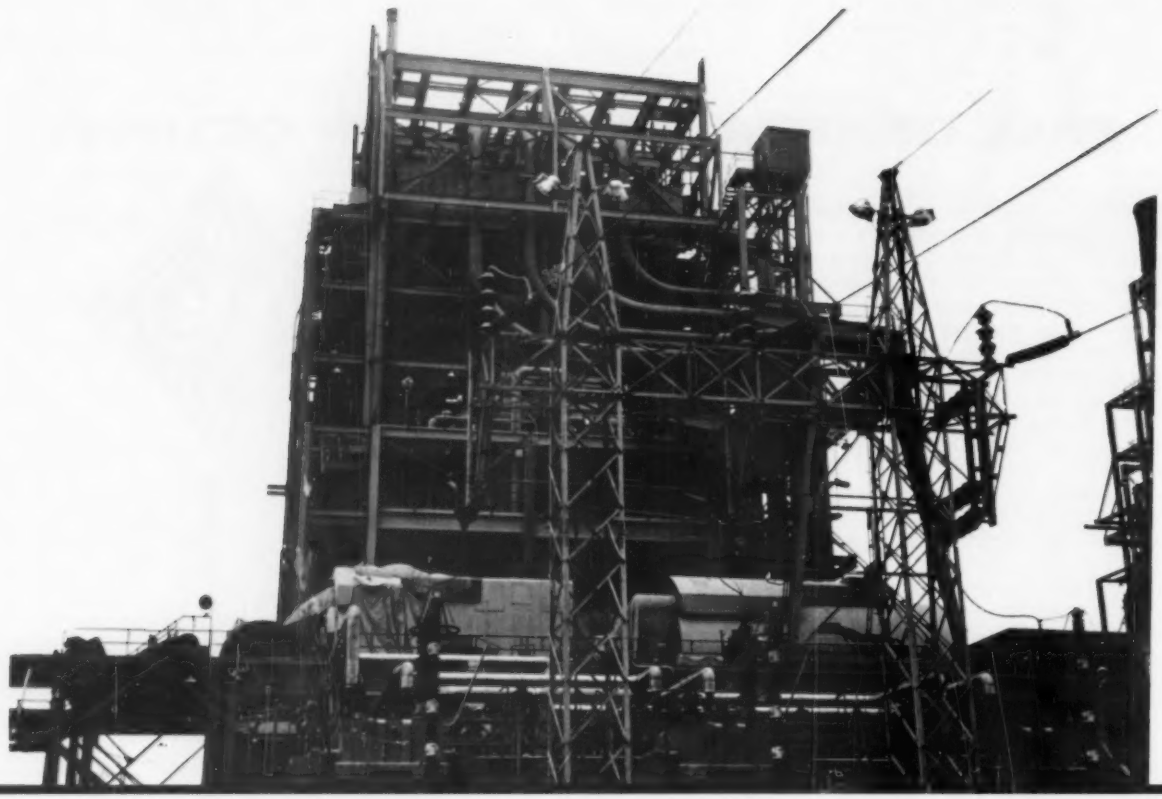
To show the ever-widening scope of the electrical engineering field, it is interesting to note the coverage of specific subjects in the program. These included: Communications (all types), Industrial Power Systems, T and D, Radiation Effects, Fuel Cells, MHD, Basic Sciences, Power Station Control, System Operation, Substations, Semiconductors, System Planning, Induction Machinery, Computers, Feedback Control Systems, Rotating Machinery, Safety, Transformers, Nuclear Energy, Excitation Systems and Synthetic Insulation. Some 200 papers were presented in the five-day session.

In the annual Awards category, the winners were: George F. Corcoran (E.E. Education), Samuel B. Griscom (W. M. Habirshaw Award), Harry Nyquist (Mervin J. Kelly Award), Theodore A. Rich (Morris E. Leeds Award), and Charles H. Townes (David Sarnoff Award).

Field trips for members included General Motors' Technical Center, Ford, Bell Telephone, Enrico Fermi Plant, National Bank, International Salt, Chrysler, Post Office and University of Michigan.

The Michigan Chapter of AIEE did an excellent job on arrangements, and Ray Mayer and Mel Krampf handled publicity in A-1 fashion. END

AIEE President Warren H. Chase



FASTER CHEMICAL CLEANING FOR HIGH-PRESSURE BOILERS

Remove copper and iron oxides together, say W. Bell of Chas. Pfizer and S. Alfano of Houston L & P Co.

A NEW CHEMICAL CLEANING process using ammonium citrate makes possible the removal of coexisting iron oxides and copper deposits by the same solution, thus avoiding time-consuming intermediate draining and rinsings.

This new process leaves the metal in a clean, passive, silver-gray condition, and requires no nitrogen blanketing or postalkaline neutralizing boils. Magnetite and copper deposits have been successfully removed from both natural circulation and controlled circulation boilers.

As power plant designs have become more sophisticated, producing steam at higher temperatures and pressures, the type of deposits accumulating in such plants has also changed. Instead of being predominantly composed of calcareous deposits originating from impurities in boiler water, deposits produced as a result of metallic corrosion predominate in higher pressure units. Iron oxides, mainly ferrosoferric oxide or magnetite (Fe_3O_4), are now a major constituent of boiler deposits, and varying amounts of corrosion deposits from other metals in the steam generating cycle may also be found admixed or coexistent with the magnetite. Of particular importance among deposits other than iron oxides are metallic copper and its oxides—Cu_2O and CuO.

Removal of operational deposits to improve heat transfer and prevent tube blockage and tube blowout is essential for efficient operation. Special considerations are required

when copper coexists with iron oxides, since dissolved copper in acid cleaning solutions tends to redeposit on the clean metal surface in thin metallic sheets. Such redeposition leads to partial tube blockage, overheating and possible tube blowout; and, obviously, the chemical cleaning operation has not served its purpose.

Various methods have been used to remove these deposits. Some methods are based on pretreatment with an oxidant which removes the bulk of the offending copper and copper oxides, followed by inhibited mineral acid to remove the iron oxide and other deposits. Frequently, this approach requires a post-treatment with copper oxidants to remove whatever copper remains.

Recently copper complexing agents as additives to hydrochloric acid have been used to inhibit the plating of metallic copper in sheets. For such additives to perform correctly there are many factors which are not easily defined or controlled. The quantity of copper present, and its physical form and location, can affect the results when using such methods. Often, a pre- or post-treatment with oxidizing copper solvents is required to reduce the initial inventory of copper or to scavenge the last traces from the unit.

Such methods give variable and unpredictable results, and often require a long time in terms of the over-all cleaning operation. Frequent draining and refilling and redraining may be involved, as well as neutralizing alkaline boil-outs. The entire operation is usually conducted under nitrogen.

A TWO-STEP PROCESS. New method is essentially a treatment with an ammonium citrate solution under conditions adjusted to remove the iron oxide matrix and the copper constituents of the deposits. Both the iron and copper are dissolved and stabilized in solution by means of the complexing properties of citrate and ammonia.

This can be visualized as a two-step process in which slightly acidic ammonium citrate dissolves iron oxides, forming stable iron-citrate chelates. Then the spent citrate solution is treated with additional ammonium citrate, ammonia and an oxidant in order to remove copper. In the second step, the copper is stabilized as soluble copper ammonium complexes; the clean metal surface resists further oxidation and has a dull, silver-gray appearance.

As seen from this brief description, the use of ammonium citrate for cleaning steam generation surfaces offers many advantages. Excellent cleaning results have been obtained in periods of time considerably less than required for standard acid-cleaning procedures. The elimination of special additives, nitrogen blanketing and neutralizers also indicates savings in both time and money.

The No. 4 Unit of the Bertron Steam Generating Station in the Houston Lighting and Power Company System was cleaned in early 1961 (Fig. 1). This is a controlled circulation boiler, having a water inventory when full of 170,000 lb. Based on an estimate of 1000 lb of iron oxide in the system, an initial cleaning solution containing 3000 lb of citric acid plus ammonia was used.

This cleaning solution was prepared as a concentrate by dissolving 3000 lb of citric acid in 2000 gal of water in a separate tank. Anhydrous ammonia (330 lb) was added to the citric concentrate making an ammoniated citric concentrate of about 15 per cent. After addition to the lower drum and complete mixing in the system, the cleaning solution concentration was 1.8 per cent and the pH was 4.5.

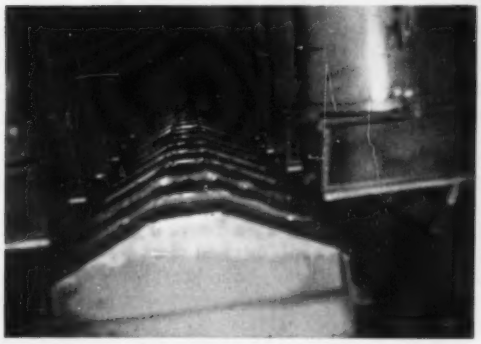
IRON OXIDE DISSOLVING PHASE

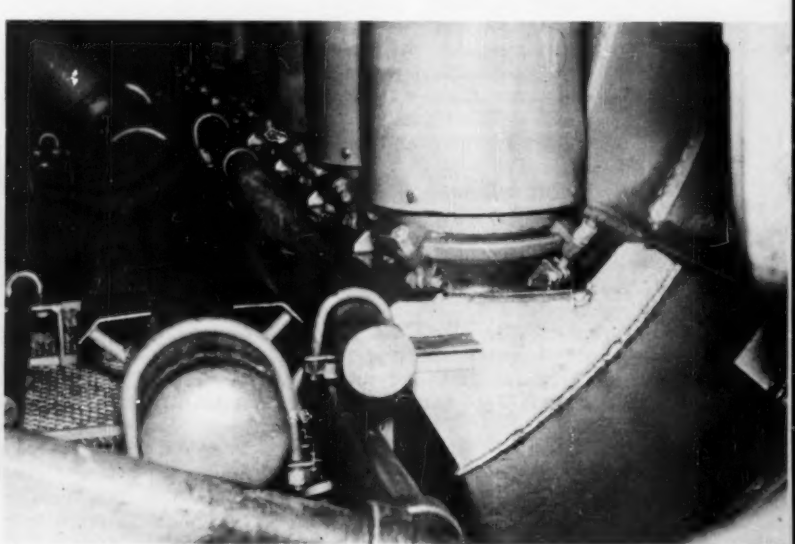
Time	Schedule
4:00 a.m.	Boiler water 200 F, ammonium citrate injection to lower drum begun. Circulation pumps operating.
5:00 a.m.	All citrate added. pH 4.5. Stop pumps.
6:00 a.m.	Start cooling. pH 5.0.
8:45 a.m.	pH 6.1. Temperature 150 F.

COPPER DISSOLVING PHASE

Time	Schedule
9:00 a.m.	Added 600 lb of citric acid (previously prepared as concentrate). pH 4.8. Pumps were operated intermittently throughout the copper dissolving phase to ensure mixing and agitation.
10:30 a.m.	Added 2000 lb of anhydrous ammonia. Temperature 150 F. pH 9.9.
10:50 a.m.	Add 400 lb of sodium nitrite (oxidant previously prepared as concentrate).
10:55 a.m.	Begin air agitation. pH 9.9.
11:20 a.m.	Continue air agitation. Forced-draft fans on. Temperature 140 F.
12:05 p.m.	Continue air agitation. pH 9.8. Temperature 120 F.
12:30 p.m.	pH 9.8. Temperature 110 F.
1:00 p.m.	Boiler drained.
6:00 p.m.	Boiler drained after four raw water rinses.

Figs. 2 and 3. Both views show clean metal surfaces of Bertron Steam Generating Station after use of ammoniated citric acid





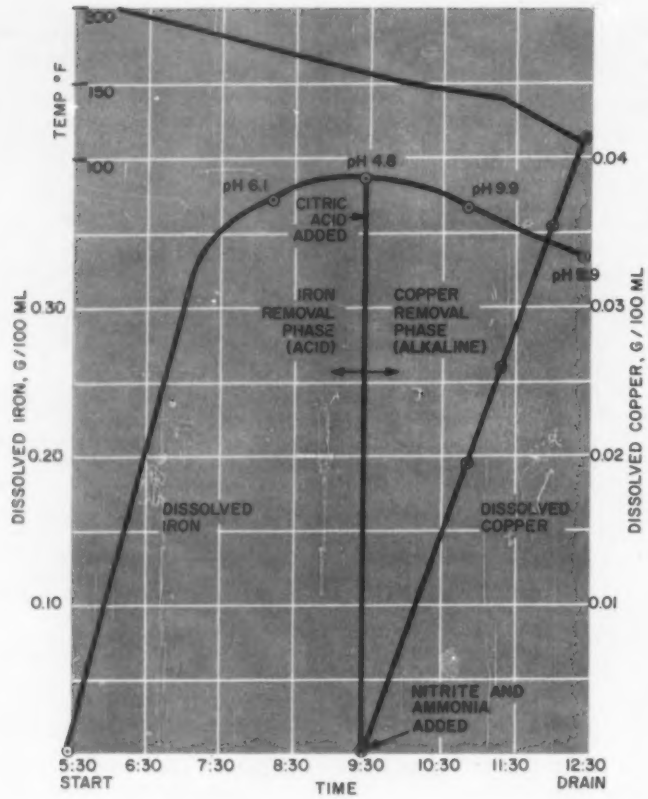


Fig. 4. Operational cleaning of controlled circulation boiler, Houston Lighting & Power Co. system

Boiler was left empty overnight, and inspected the next morning. All metal surfaces, including orifices, were dull silver-gray with no smudge or residues (Figs. 2 and 3). Surfaces remained passive for the duration of two weeks' outage.

During cleaning, samples of the cleaning solution were withdrawn for dissolved iron and copper analyses (Fig. 4). Approximately 930 lb of magnetite and 70 lb of copper were dissolved chemically and removed. No measurement was made of deposits not completely dissolved, but there was some sloughing of the deposits from the metal surfaces. An estimated additional 100 lb of iron oxide and 10 to 20 lb of copper were so removed.

Several other boilers, both of the controlled circulation and natural circulation types, have been cleaned with similar results. Based on many laboratory experiments and on the practical field use of ammonium citrate, suggested procedures are outlined below. Naturally, many modifications are possible, which again points to the flexibility of the method.

PROCEDURE FOR DRUM-TYPE BOILERS. 1. Cool unit to 200 F and add a previously prepared solution of concentrated ammonium citrate. The concentration of citric acid, after addition to the unit, should be at least 1 per cent, and there should be sufficient citric acid to dissolve the suspected quantity of magnetite (2.5 lb of citric acid = 1 lb Fe_3O_4). The quantity of ammonia necessary to prepare the ammonium citrate solution is 35 to 45 gal of aqueous 30 per cent ammonia per 1000 lb of citric acid. The pH of the cleaning solution in the unit should be between 3.0 and 5.0. If 1 per cent citric acid is used, the pH should be at least 3.5, while 3 per cent citric acid should have sufficient ammonia added to produce a pH of at least 3.0 in the unit. Solutions containing 3 per cent citric acid should be used when the quantity of iron oxide is not known.

2. Pumps should be operated until mixing is complete. The unit may be cooled to 160 to 180 F by operating cooling fans intermittently—perhaps 5 minutes each half hour.

3. After about 4 hours, the dissolution of magnetite should be complete and the pH of the solvent, as a result of this reaction, is usually between 5.5 and 6.5; the temperature may be as low as 150 F.

4. An additional quantity of citric acid is added to increase the stability of the solution to iron oxide precipitation at the higher pH to be reached during the copper removal stage. The quantity of citric acid, which is added first, is usually about 0.5 per cent of the cleaning solution weight.

5. Immediately after the extra citric acid is added more ammonia is added to the system until the pH of a homogeneous sample is between 8 and 10—preferably above 9.5. The amount of anhydrous ammonia required to raise the pH of the cleaning solution is approximately 1 per cent of the weight of the cleaning solution.

6. When the ammonia addition is completed, the oxidant is added. Air injection has been found to be completely adequate, but other oxidants are also suitable and may be more desirable for oxidizing certain units. An especially effective oxidant system is a combination of air and sodium nitrite (0.25-1.00 per cent). Forced-draft fans are operated to cool the solution from 150 to 100 F during the copper removal phase. A total oxidizing time of 4 hours is usually sufficient and in some cases the aeration period has been 2½ hours.

7. After completing the copper removal phase, the cleaning solution is drained to waste.

8. Rinsing with cold water to remove traces of remaining cleaning solution is then begun. Rinsing should be continued until such traces are removed, as determined by pH and iron analyses.

ONCE-THROUGH BOILERS. Critical and once-through boilers should be well suited to the use of this process. If a return tank is provided from which a solvent circulating pump can return the solution to the unit, aeration and the addition of oxidants and ammonia can be accomplished directly in the return tank. If ammonia fumes and odors are objectionable, other amines may be used. For instance, nonvolatile triethanolamine can be used to produce an alkaline solution, and has the ability to form stable complexes with iron and copper. Laboratory experiments have indicated its usefulness at times when ammonia itself is not desirable. END

Left to right: Lt. Col. W. E. Campbell, A. V. Logreen, Col. H. J. Stehling, Col. W. C. Fowler, J. Lockhart, Maj. Gen. J. B. Knapp, Maj. Gen. A. M. Minton, Editor Bob McCaw, A. I. McCone, A. F. Ahearn, G. R. Molinaro, J. T. Seaman. Air Force-Industry group at Univ. of Wis. toured campus facilities, power plant

AIR FORCE AND INDUSTRY COMPARE POWER PRACTICES

COMPARISON OF power facilities and maintenance management techniques was the purpose of a recent Air Force-Industry Tour. A group of top people from the Directorate of Civil Engineering (Hdq'trs. USAF), and men in charge of facilities from private industry, compared notes—in visits to a number of installations in the U.S.

In charge of some $14 billion in investment and $821 million in operation and maintenance expense, the USAF's Directorate of Civil Engineering is constantly seeking to conserve utilities and to "hold the line" in maintaining ever-increasing weapons systems, under the responsibility of the Air Force.

As part of its improvement program, the Air Force regularly compares notes with private industry in an interchange of information and ideas. It is a most sensible—and logical—way of gaining yardsticks for comparison.

The general public is not aware of the tremendous amount of power and electronic equipment involved in maintaining our air bases around the world. In addition to the regular utilities required for support of the personnel on the bases, there is a great demand for power to support missile sites, shops, hangars, radar locations, and many other requirements.

All of this activity comes under the direction of Maj. General A. M. Minton, Director of Civil Engineering for the USAF, who is largely responsible for the present highly efficient operating program of the Air Force. He is ably assisted by a very competent staff, including Major General Knapp (SAC), Col. Fowler, Col. Stehling, Lt. Col. Pierce and others.

INSTALLATIONS VISITED on this tour included: U.S. Steel's Gary Plant; G.E.'s Gas Turbine plant at Evendale, Ohio; R.C.A.'s Plant at Indianapolis; University of Wisconsin's plant at Madison; SAC Headquarters at Omaha; Lowry AFB Missile Site; and Schilling AFB, Salina, Kansas.

At each location, the visits included tours of the power facilities, plus briefings on the prevailing maintenance management systems. Since both industry and the military have common problems, in this respect, the group was afforded the opportunity of comparing operations at the working level.

Heaviest power facilities were, of course, seen at U.S. Steel's Gary Works. However, each stop on the tour gave the group a chance to see widely varying types of systems. Even the underground mis-

Left: Supt. of Power Jack T. Seaman with Editor Bob McCaw in U. S. Steel's Gary Plant. Above (l to r): G. R. Molinaro explains steel mill problem to Gen. Minton, Jack Seaman, and Editor Bob McCaw

sile silos are equipped with most complete diesel generating plants and very complicated power and control distribution systems.

Importance of this tour was evidenced by the fact that Mr. Alan McCone, Special Ass't. to the Air Force, made the complete trip, and offered much valuable advice based on his wide past experience. (Mr. McCone was formerly with Catalytic Construction Co. in Philadelphia.)

OTHER MEMBERS of the tour were: Maj. General A. M. Minton, Maj. General J. B. Knapp, Col. W. C. Fowler, Col. H. J. Stehling and Lt. Col. W. E. Campbell (all of the Air Force Dir. of C.E.). Also: Bob McCaw (Editor, POWER ENGINEERING), J. T. Seaman (Supt. of Power, U.S. Steel's Gary Works), G. R. Molinaro (Ass't. Supt. of Maintenance, U.S. Steel), John Lockhart and A. V. Logreen (G.E. Co.), Robert Larsh (R.C.A.), and A. F. Ahearn (University of Wis.).

Indicative of the power problems at a typical Air Force Base are these statistics: primary feeder voltage: 69 kw, substation capacity: 20,000 kva, 140 miles of overhead lines, 64 miles of underground cable lines, 435 distribution transformers. This, plus 13 boiler plants, complete water and sewer systems, and large cold-storage operations—in other words, a complete city of 15,000 persons *plus* all of the complicated power facilities required to support an Air Force activity.

It will be recalled that in Sept. 1960 (p. 68), POWER ENGINEERING printed a rather complete article on a Heat-Power Conference which had been conducted by the Air Force at Wright-Patterson AFB, Dayton, Ohio. At that meeting some of the top experts from Industry and Utilities met with the power people of the Air Force to discuss problems of generating and heating plants.

Also, in Dec. 1960 (p. 76) and Jan. 1961 (p. 73), we ran the story on the Air Force's Floating Power Plant in the Arctic, which described a very unique application of a complete steam-electric generating plant installed aboard ship which was floated to the Arctic and permanently moored as a floating power plant. This installation supports a radar warning station, and the power involved is highly critical.

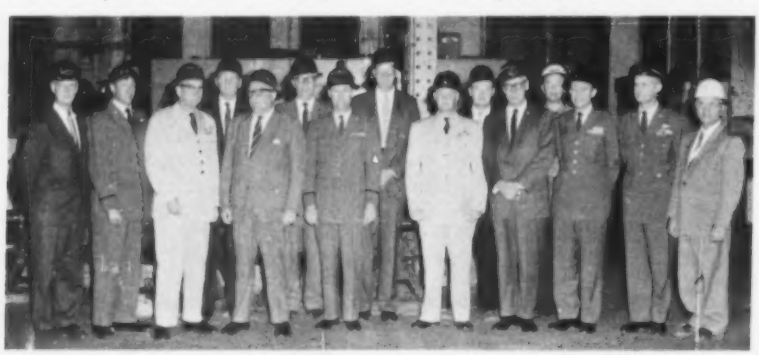
The two items mentioned above show dramatic proof of the awareness which the Air Force has of its power facilities around the world. In both cases, a most aggressive management backed by top-flight engineering assistance has been evidenced.

IN A PERSONNEL IMPROVEMENT program instigated by General Minton, a large percentage of the engineers in charge of Air Force facilities are registered professional engineers. It is gratifying to note that such a high degree of talent is in charge of our nation's facilities—so important to our national defense.

At each base, the maintenance and operation of all power facilities (plus buildings and grounds) is under direction of a highly-skilled Base Engineer Officer and his staff. These men, in turn, receive over-all guidance from C. E. Headquarters in Washington.

It is a fine commendation to note that the Industry members on the tour were highly impressed with the degree of efficiency in maintenance by the Air Force; also, that their standards are well above those in industry—in general. END

Entire Air Force-Industry group on tour in Gary Works of U.S. Steel



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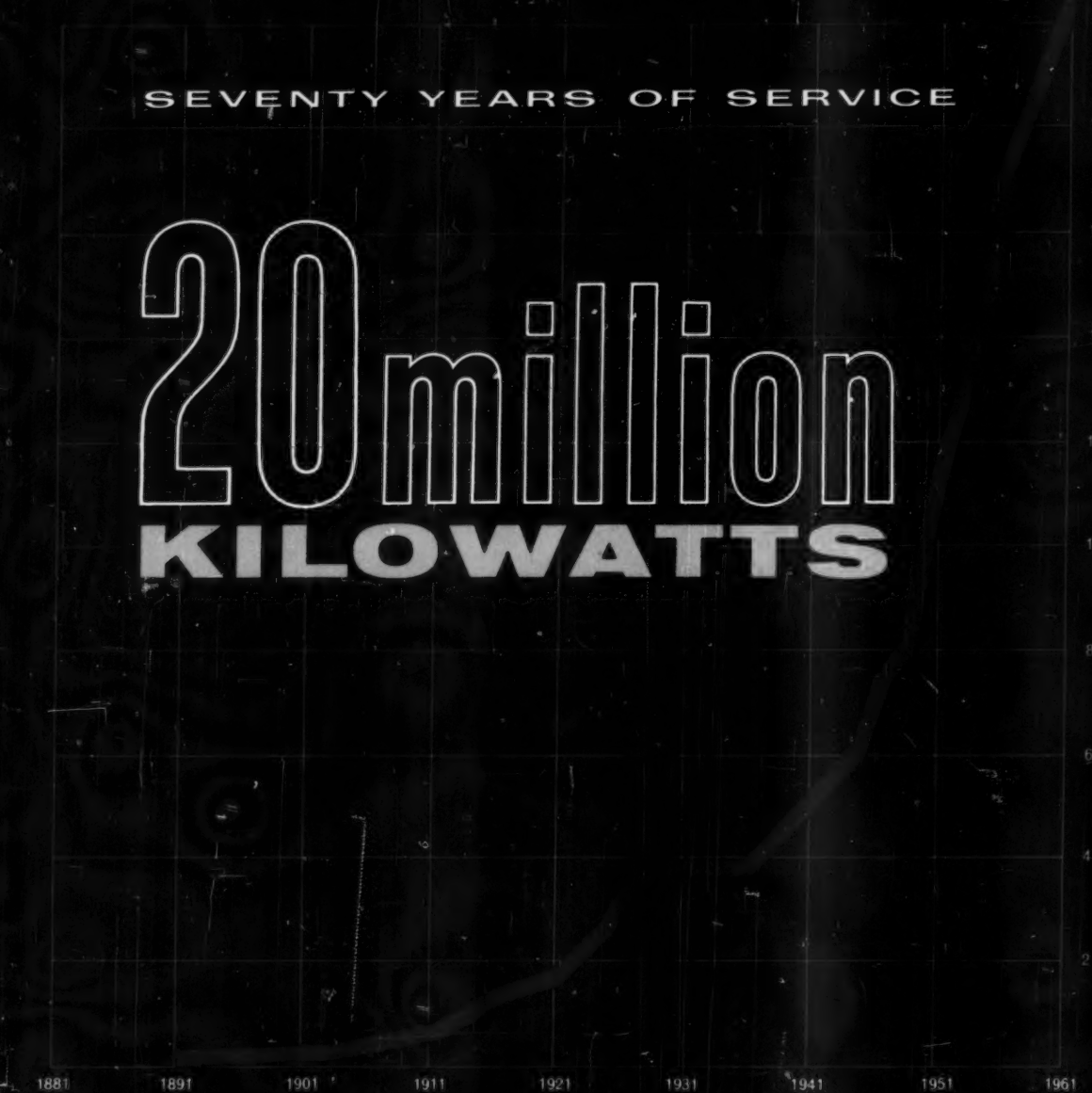

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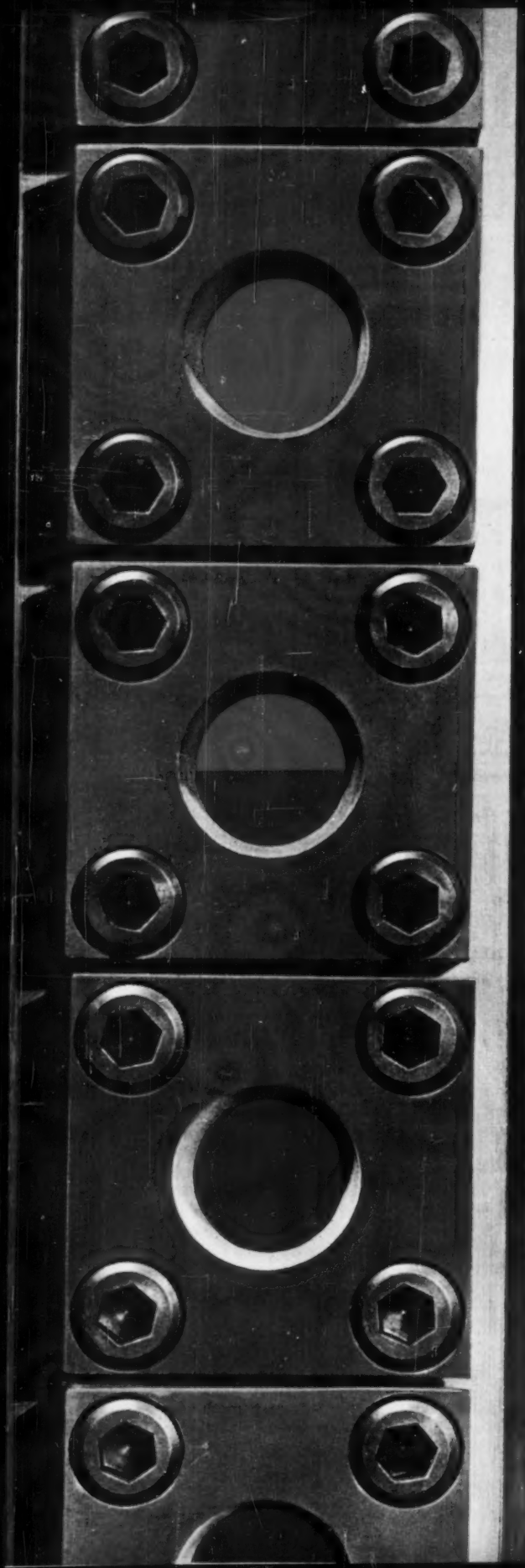

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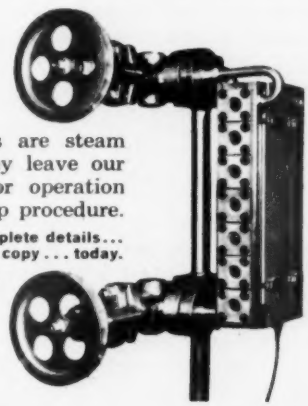

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ANOTHER MILESTONE IN THE POWER INDUSTRY

Philip Sporn

Donald C. Cook

Philip Sporn retires as President of American Electric Power Company. Donald C. Cook takes command

AMERICA'S UTILITY Hall of Fame adds another great name this month, as Philip Sporn retires. He is being succeeded by Donald C. Cook, as president and chief executive officer, effective December first.

"Phil," as thousands of friends and associates know him, has probably done more than any other person in his day to advance the art of electrical generation and transmission. He is well known, both here and abroad, for his aggressive pioneering in all phases of the power field.

Born in Austria in 1896, Phil was brought to America by his parents and was naturalized in 1907. After graduating from Columbia University in 1917, he went on to receive many honorary degrees, including those from Ohio State, IIT, Marshall, Hanover, Stevens, Brooklyn Polytech, Indiana Tech, Tri-State College, University of Grenoble (France) and Haifa Technion (Israel).

Philip Sporn has been associated with American Electric Power since 1920, and has been president of the parent company and all of its subsidiaries since 1947. Having started as an assistant engineer, he became chief electrical engineer in 1927 and chief engineer in 1933.

He has devoted much time and effort to nuclear energy and its application in power generation. He is a former president of Nuclear Power Group, Inc., and has been chairman of the Research and Development Committee of the East Central Nuclear Group, Inc., since its formation in 1958. He was instrumental in the formation of Ohio Valley Electric Corporation, an organization of 15 private utilities providing electric power to the Atomic Energy Commission's Portsmouth (Ohio) Project, and has been its president since 1952.

Phil Sporn has been active as a consultant and advisor to various Federal agencies and educational institutions, including Columbia, Princeton and Cornell Universities, and Massachusetts Institute of Technology, as well as to private and governmental agencies in several foreign countries, including Israel. Among his many posts, he has been a trustee of the Committee for Economic Development, member of the Board of Governors of Weizmann Institute of Science, director of The Advertising Council and of Edison Electric Institute.

In addition to being head of one of the world's largest utility systems, Mr. Sporn has had a 1,100,000-kw electric generating plant named for him. The AEP System has a total generating capability of over 6500 Mw, with another 1500 under construction. Its total assets currently exceed $1.5 billion.

Former Executive Vice-President Donald Cook brings a wealth of experience from his seven years with the company, plus many more in private practice and in government positions. One of these was as a Commissioner of the Securities Exchange Commission.

Donald Cook was born in Escanaba, Michigan; he received his bachelor's and master's degrees in business administration from the University of Michigan in 1932 and 1935, respectively, and the degrees of juris doctor and master of laws from George Washington University in 1939-40, respectively. He is also a certified public accountant.

In other AEP Board actions, H. A. Kammer was elected senior vice-president; he has been executive vice-president, engineering and construction. He has been with the company for 37 years, having come up through the ranks from assistant design engineer.

Phil Sporn will continue to help the advance of the power industry in his new capacity as Chairman of the AEP System Development Committee. He will also act as an advisor to officers of the company, and will continue as a director and member of the executive committee. END

Hall Industrial Water Report

VOLUME 9 DECEMBER 1961 NUMBER 6

Signal 32

When this emergency signal goes out to New York City police, crime specialists immediately go into action. First in the field, then as required, other specialists come from headquarters and the laboratory.

Hall Laboratories has no special signal, but any water problem calls the Hall service team into action. First contact by a field engineer will handle most situations that arise. Should he need assistance, he is backed up by the district service manager, the staff at headquarters and both local and central service laboratories.

Like the police officer, the Hall field engineer is committed first to detect and prevent potential trouble. You can use Hall water "detectives" in your plant to avoid or correct water problems—to "police" your plant water everywhere—to assist your engineers with water management for the most efficient use of water from procurement to disposal.

Unscheduled outages

An eastern steam power plant had five unscheduled outages in nine months. All were due to overheating and failure of secondary superheater tubes because of deposits. After four outages the superheater was acid cleaned in an attempt to avoid further trouble. Less than two months later the boiler was down again.

The plant engineer called Hall service manager E. C. Eger. After establishing that deposits resulted from the presence of high-solids zeolite-softened water in the boiler feedwater used for desuperheating between the primary and secondary superheaters, Eger concluded that they were water soluble. This was quickly confirmed. Instead of acid cleaning, the operators devised a gadget to facilitate washing each element with hot water. A conductivity test was used to determine when each tube was clean.

The water wash was completed in 24 hours at a cost of $285. Acid cleaning had required 54 hours and the bill was $7,360 . . . a worthwhile reduction in cleaning cost. And with the real cause of difficulty in focus the operators were able to avoid much of the contamination of the feedwater with treated water.

Unusual tube failure

It was not expected that the mark of quality on this boiler tube would play a part in its undoing, however, a symbol was stamped on the external surface. This notch effect focused fluctuating stress at the mark and failure occurred due to stress corrosion. The whole blame can't be placed on the mark, but it did accelerate failure.

Hard water search

A paper mill called Hall field engineer, J. A. Ivancic when phosphate would not show up in the boiler water despite a greatly increased chemical feed rate. Hard water had to be getting into the boilers even though hardness tests showed the condensate to be satisfactory and the treated make-up water to be normal.

Ivancic checked feedwater from the boiler feed pumps. Hardness was unusually high indicating feedwater contamination between the softener and feed pumps. Lack of sampling connections between these two places made it impossible to quickly locate the exact point of contamination.

Since the trouble spot could not be located chemically, the plant engineers and Ivancic decided to have a brainstorming session at lunch. Someone suggested leakage at the vent condenser on the condensate heating section of the hot process softener. He hit the nail on the head. Routing the cold, raw water around the condenser brought conditions back to normal.

Sweet and sour

A candy company ran into trouble with serious corrosion of circulating cooling water pipe and candy cooker circulating water return pumps.

Investigation by Hall field engineer, J. A. Hvizdos, showed the trouble to be low pH value in the circulating water. It was below 6, whereas under normal conditions, it should have been greater than 8. Further investigation proved the absence of mineral acid contamination. The contaminant had to be organic.

Under certain conditions, sugar will decompose to form acid organic materials. Hvizdos found this happening with the sugar or acidic materials getting into the circulating cooling water at the vacuum candy cookers.

Once the problem was diagnosed, the cure was obvious. Alkali chemical was fed to the circulating cooling water to produce the necessary increase in pH value.

Want more information?

The many ways industry can use Hall Laboratories industrial water consulting services are described in a 24-page brochure.

For your copy, write on your letterhead to:

HALL LABORATORIES
HAGAN CENTER, PITTSBURGH 30, PA.
Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

DIVISION OF **HAGAN** CHEMICALS & CONTROLS, INC.

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Solar's experience with rectangular expansion joints can help solve your difficult ducting problems

FORTY OF AMERICA'S FIFTY largest businesses—steel, power, petroleum, petrochemicals and others—use *Sola-Flex®* expansion joints to help solve difficult ducting problems and extremes of thermal growth.

Solar is the most experienced manufacturer of rectangular expansion joints in the world. Two types of rectangular expansion joints are available: U-span with radius corners and V-span with camera-type corners. Sizes range up to 26 ft by 20 ft. Made from all types of stainless steel, Solar rectangular expansion joints withstand both axial and lateral movements and temperatures up to 1000°F. Pressure ranges from vacuum to 15 psig.

Hot or cold, large or small, high pressure or low—no matter what your particular ducting need, Solar can deliver the right expansion joint for any job. Forty-eight *Sola-Flex* expansion joint distributors are located throughout the nation and overseas. They can assure prompt service and advice for users everywhere.

For more information about *Sola-Flex* expansion joints, write Dept. J-161, Solar, San Diego 12, California.

SOLAR

A Subsidiary of International Harvester Company

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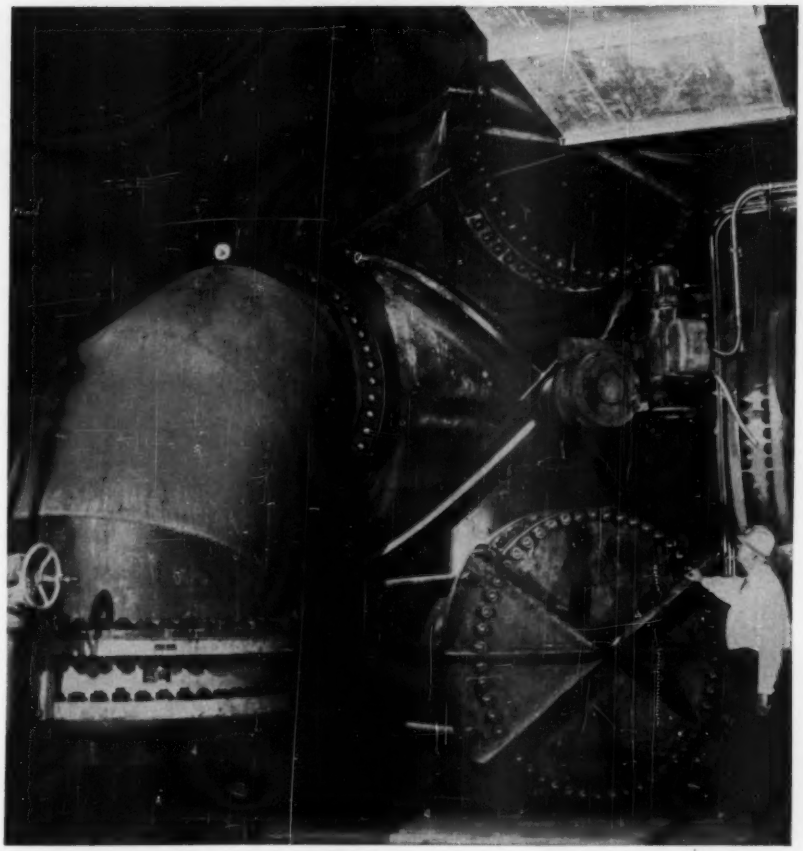
This installation in a southern power plant is typical of Henry Pratt's ability to fill all the needs of circulating and service water systems.

At left is shown a standard rubber seat butterfly valve, the type that filled most of the valve requirements. At right is one of six 60 inch tank-type reversing valves in this plant designed to automatically reverse flow of the circulating water system thru the condenser tubes.

When you need valves, it is worth while discussing your plans with a Henry Pratt representative. You'll find a useful depth of experience, a wide range of economical standard valving, design ability that leaves no limit to specials . . . and the advantage of having one supplier for all large valving.



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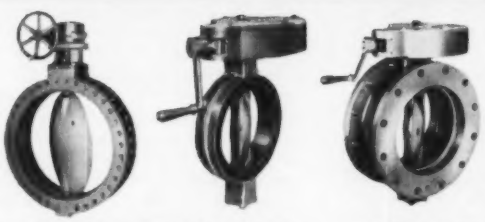

RUBBER SEAT BUTTERFLY VALVES . . . BUBBLE TIGHT

The RIA valve above offers the smallest face-to-face dimension for service to 100 psi of any comparable valve. In sizes from 24" up. Comes also in combination with space-saving expansion joint for condenser water circulation. **Catalog B-3G**

Monoflange and 2FII valves are wafer and flanged type in sizes from 3" thru 20". Pressures to 150 psi. Offer space savings and rugged dependability for many jobs. Wide variety of Manual Automatic Operators. **Catalog B-11G**

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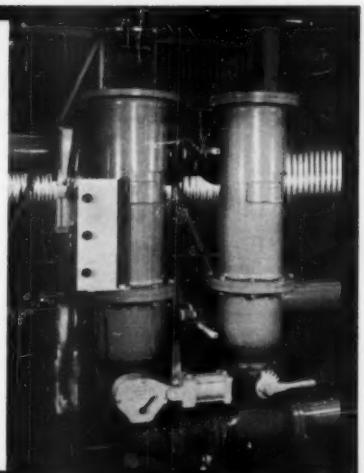
Unique new strainer utilizes a powerful swirling action—keeps larger particles from basket and forces them toward trash outlet. Stays on line longer; requires less cost and maintenance than similar units. Compact multiple units save space, meet any flow requirements or pressure drop. Back-washing with auto or manual controls.

Catalog S-1G



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Illustrated are a few of the many types and sizes of Rotojet Tube Cleaners driven by air, steam or water. We analyze each application before recommending equipment that best meets the requirement.

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new power construction

Benton, Ark.—City Utility Commission, City Hall, has authorized plans to extend and improve the municipal power plant, an expenditure to exceed $650,000. Work will include installation of a 3000-kw generator unit with auxiliary equipment for increased capacity. Work on the expansion will begin soon and is scheduled for completion by the summer of 1963.

Denver, Colo.—Directors of Public Service Company of Colorado, Fifteenth and Champa Sts., Denver, Colo., and Colorado Central Power Company, Golden, Colo., have announced approval for a merger of the two companies based on the approval of the stockholders and the regulatory bodies of the State. The merger is expected to become effective early in 1962 with Public Service Company of Colorado, the surviving company. Holders of Colorado Central common will receive one share of Public Service common for each one and two-thirds shares. In 1960, Colorado Central had gross operating revenues of more than $7,975,000 and Public Service had gross operating revenues of $112,689,211.

Estes Park, Colo.—Estes Park Village Commission, Town Hall, Estes Park, will have plans prepared soon for extensions and improvements in the municipal power plant with installation of equipment for increased capacity. Project will get under way soon and is scheduled for completion by the fourth quarter of 1963. Construction of a new substation is also planned.

Edge Moor, Del.—Delaware Power & Light Co., 500 Market St., Wilmington, Del., has announced that it has deferred plans for the construction of a fourth 150,000-kw generating unit at its Edge Moor Power Station located here. Instead, the company will install an 11,700-kw capacity gas turbine-generating unit at its Wilmington substation and a 12,900-kw unit at this location to handle peak load requirements. Installation of these units represents a marked saving since the original project was budgeted for about $29,600,000, over a three-year period. Estimated cost of the two turbine installations was placed at $2,250,000. The two units will be supplied by General Electric Co. and Pratt & Whitney Co., Inc., and are expected to be in operation by late fall of 1962.

Lakeland, Fla.—City Department of Lighting, City Hall, has announced plans to install three new-type gas turbine-generators to be used as peaking units at the municipal power plant here. Work on the installation sites has already begun, and when three units are completely installed it will represent an investment of approximately

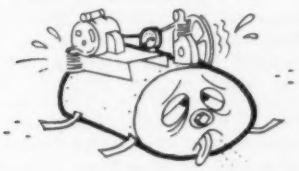
ONE OF A SERIES OF CHATS ABOUT THE CONSERVATION AND CONTROL OF HEAT

SARCO TOPICS

PREVENTION OF CRUELTY TO OLD COMPRESSORS

You've got at least one air compressor, of course. Doesn't everybody? And there it sits, pumping its heart out for you year in and year out. And you there, Simon Legree, do you ever give it a break and measure its capacity?

One measure is the useful work done by your compressed air tools, of course. However, this yard stick may make your compressor installation seem way oversize, but don't blame the equipment. The puffing oldster isn't responsible for choked intake filters, poorly designed suction pipes,



overcooling, undercooling, inadequate distribution mains and wet air. All these things can cost you.

Off and on we're going to talk about compressors in these pages, if you don't mind. It's a big subject and the lesson for today will be confined to the air intake. Can you imagine a more logical place to start?

Where to locate the intake? Easy. Where the atmosphere is clean and cool and dry. Dirty air and grit choke filters and eventually get through to cause wear. The cooler the air, the more you can compress per revolution. You'll get 10% more air delivered at 40°F. than at 90°F. And dryness is imperative, because compressed air can't contain all the moisture it can hold in its uncompressed state. Where does the moisture go? Into mains, tools, and valves, unless it's removed. And need we add that chemical fumes cause corrosion? That includes exhaust gases from engines and furnaces. CO_2 in the presence of oxygen and moisture can rust your valves, tools, nozzles and sprays.

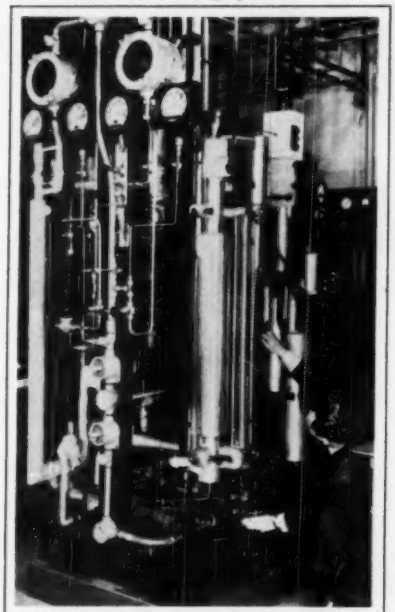
How about intake size? Keep pipes short, sized right, and straight as possible. Small pipes with snaky bends reduce pressure and capacity. For an educated example, a pressure loss due to friction in the intake pipe and filter of 2 psi (14.7 to 12.7) will reduce output of a 125 psi compressor by 7.5%.

How do we know so much? Well, as we continue in future issues, we'll be talking drains and traps and cooling and safety controls for compressors—all of which we manufacture. That's how we know so much. If you can't bear to wait, just write. It's that easy to get information out of us.

SARCO AND THE FLYING DUTCHMAN

In the pipe shop of a major office building complex on New York's east side, the Flying Dutchman flies again. This is really a bright idea which could well become standard practice elsewhere, because it's the kind of logical precaution that would make sense anywhere.

The chap in our photograph is putting together, according to precise, dimensioned drawings, an assembly consisting of a Sarco Thermo-Dynamic Steam Trap, Type TD-50, a Sarco strainer, and valves and fittings for stock. The assemblies will be used for quick and easy replacement in the event of failure or any possible maintenance requirement in the steam distribution system, the heating system, or the air conditioning system.



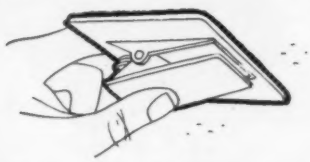
WORLD'S LARGEST ESPRESSO MACHINE?

No indeedy. It's a pilot plant Hydrofiner unit built by The Lummus Company at its Engineering Development Center in Newark, New Jersey. And its presence here is due to the fifteen ⅜" Sarco Thermo-Dynamic Steam Traps which vent and drain its 35 pound tracer lines plus a ½" TD-50 as a main drip. Nice to be picked for projects like this. Makes us proud.

We'd like to be able to report that this plan recently saved thousands of people from freezing or roasting during a crisis. So far, however, the assemblies have proved to be an ornamental kind of insurance policy. Alas, there have been no failures. That dog-goned Sarco performance is just too reliable for its own good.

WE'VE GOT THINGS TO GIVE AWAY

First of all, we have a new spring clip to hold together a bunch of papers on your desk, or something. It's not complicated, but it is difficult to describe, so we've gone to the tremendous expense of having our local Michaelangelo sketch it here. If you have no papers to hold together, it makes a rather delightful snapping noise that might amuse you. Oh yes—it also has a cross section of a TD-50 steam trap printed on it which actually *moves* when you wiggle your eyeballs at it. In case you *still* don't know how a TD-50 works, this is for you.



Second, we've still got engineers' sketch pads which we enjoy giving away so much we're offering them again. In case you're new here (Hello!) they contain isometric grid paper for use by anyone involved in piping or hookup sketches for process or heating applications.

And the famous Sarco key chain, which is really exactly that—a chain—about 60 times as handy as a fat case, we're offering again too. This has a TD-50 replica attached, but detachable. Call it tawdry promotion if you will, but our super-aesthetic wife wears one proudly around her neck.

All of these are available from your Sarco representative. Or, if he's out, write in.

There's really no reason to keep this conversation one-sided. After all, we're both interested in these subjects or you wouldn't have read this far. So write, even if it's only about a difficult problem.

7826

SARCO COMPANY, INC., 635 MADISON AVE., NEW YORK 22, N.Y.

STEAM TRAPS • TEMPERATURE CONTROLLERS • STRAINERS • HEATING SPECIALTIES

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two new INTERCHANGEABLE trays for support of cables, wiring and tubing

★ Engineered for uniform design and easy installation
★ Steel or aluminum construction
★ Complete accessories for SPEEDIER Installation
★ No sharp edges to damage cables
★ Complete interchangeability

Now, for the first time, two types of cable trays, one a ladder type and the other a basket type, are available to be used INTERCHANGEABLY at any given location, depending on the type and weight of the cables to be suspended. The advantages of each type tray can thus be used to the fullest extent. Globetray, the ladder type, is intended for use where festooning is not a problem, while Cable-Strut, the basket type, is intended for the support of communication wire, instrument tubing and control cables in automation applications.

These two cable trays have been thoroughly field tested in hundreds of large industrial installations, in new plant construction, in power plants, in modernization, and for power distribution in all types of manufacturing processes. A new catalog, just off the press, gives full information and installation techniques. Ask for your FREE copy today.

Distributors are to be found in all principal cities—consult the yellow pages in your phone book under "Gratings" or "Conduits" for the one nearest you.

189

PRODUCTS DIVISION

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$4,500,000. Work is being supervised by Reynolds, Smith & Hills, and Wellman-Lord Engineering Co., Inc., both of this city, acting as consulting engineers of the project.

Arco, Idaho—Atomic Energy Commission, Idaho Operations Office, Idaho Falls, Idaho, announced that it has extended its contract with Phillips Petroleum Co., Bartlesville, Okla., to operate a number of facilities at AEC's National Reactor Testing Station located here. The extension is for a five-year period at an estimated total cost of $137,500,000, and is scheduled to expire in February 1966. Under its provisions, Phillips Petroleum Co. will continue to operate the materials testing reactor, the chemical processing plant, the engineering test reactor, special power excursion reactor test and central plant facilities. The company also will do research and development work.

Decatur, Ill. — Illinois Power Co., 134 East Main St., has announced projected construction expenditures of $164,000,000 through 1964 for major additions and improvements to plant and equipment for increased capacity. Expenditures in this direction will exceed $35,000,000 this year, $35,000,000 in 1962, $54,000,000 in 1963, and $40,000,000 in 1964. Income from operations is expected to be necessary until early 1963.

Great Bend, Kansas—Western Light & Telephone Co., 2025 Forest St., has authorized plans for a major addition to its power plant located five miles northwest of Great Bend. Plans include the installation of a steam-electric generating unit with an initial capacity of 75,000-kw at the company's Arthur Mullergen plant. Work on the new addition will begin at once with completion scheduled for the fall of 1963. Cost is expected to run approximately $1,000,000 with equipment. Black & Veatch, Kansas City, Mo., are consulting engineers of the project.

Chalk Point, Md.—Potomac Electric Power Co., 920 E. St., N.W., Washington, D.C., has authorized plans and will start construction soon on a multi-million dollar plant installation at this location, where a large site has been selected, near Benedict, Md., on the Putuxent River in Prince Georges County. Plans call for the installation of two turbine-generators, each with a capacity of 335,000 kw, to be built and installed by the General Electric Co., Schenectady, N.Y. First unit is scheduled to be placed in line by mid-1964 and the second sometime in 1965. Preliminary ground preparation at the site is already under way and installation, when completed, will represent an investment exceeding $105,000,000.

South Boston, Mass.—Boston Edison Co., 178 Tremont St., Boston, Mass., has authorized plans for a major addi-

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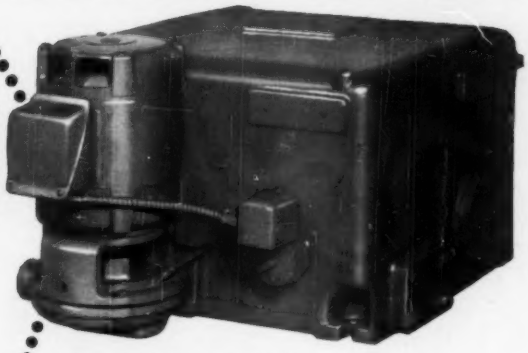
Your Best Buy

CONDENSATION TYPE "HCS" SINGLE UNIT

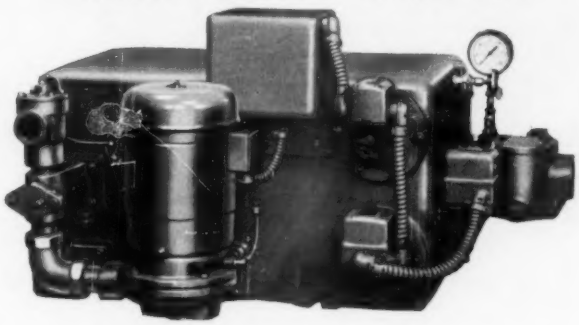


Single and Duplex Units

Capacities through 150,000 sq. ft. E.D.R.

Featuring compact, Centrifugal Pump Design

VACUUM TYPE "HVS" SINGLE UNIT



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Featuring Hoffman Jet Vacuum Producer

Thousands of industrial and commercial steam systems use Hoffman Centrifugal Type Pumps year after year for rapid, low-cost removal of condensate and air from steam lines, and return of condensate to the boiler. Efficient Hoffman Pumps, with all bronze fittings and cast iron receivers, are designed so that all parts subject to wear can be easily inspected, serviced or replaced without disturbing piping. For small systems, Hoffman's line of quality-engineered "Watchman" Condensation Pumps have ratings up to 12,000 sq. ft. E.D.R. Hoffman sales-engineers are available at all times for consultation.

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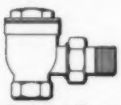

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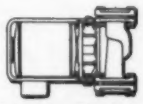

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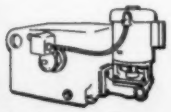
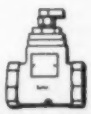
VALVES • TRAPS • PUMPS • STRAINERS • REGULATORS



Condensation Pumps



Flow Control Valves

Zonal Valves

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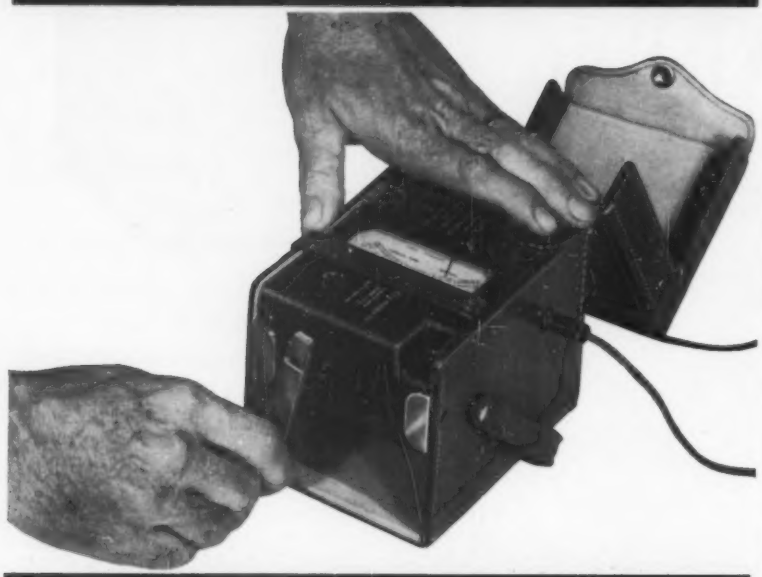
MEGGER® INSULATION TESTER



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CONSTANT TESTING VOLTAGE • MEGOHM AND OHM SCALES

Compact, completely self-contained Mark III instruments require no batteries or other power supply. Built-in hand-driven generator with folding crank provides constant testing voltage for circuits with capacitance of up to 4 microfarads. Specially designed ohmmeter measures value of insulation resistance directly in megohms; double scale instruments *including* ohm scale also available on all models. Leads store in handy camera type case, plug into spring plunger type terminals for use. Ideal for detecting faulty insulation on motors, generators, rotary converters, transformers, power cables and wiring, lighting circuits, control equipment and wiring. Available in three models for a wide range of testing applications.

Voltage	Range
100 volt	0.02-20 megohms
250 volt	0.05-50 megohms
500 volt	0.1 -100 megohms

All models available with 0-10,000 ohm scale

The new, improved Mark III is the *practical* answer to the need for test accuracy and dependability at low instrument cost. Write for Bulletin 21-85-PE.

B-129

BIDDLE INSTRUMENTS

JAMES G. BIDDLE CO.

Electrical & Speed Measuring Instruments

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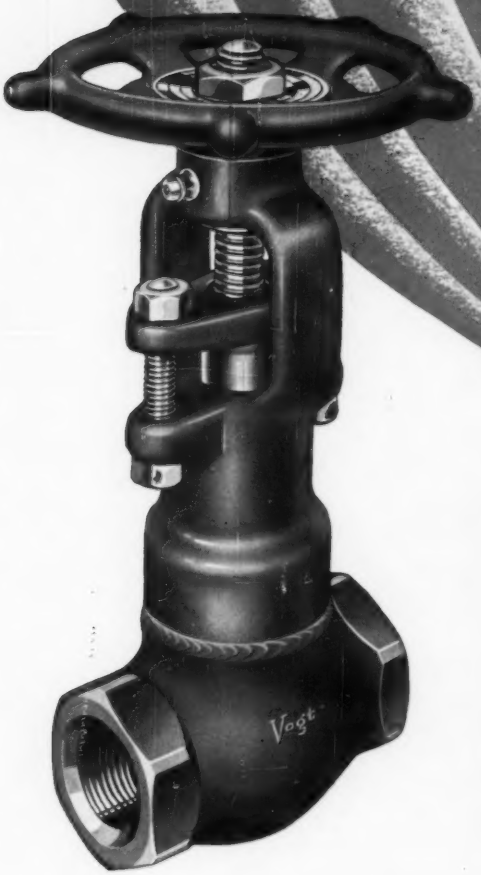
tion to its L Street Station at this location. Included in the plans is the installation of a huge generating unit with an initial capacity of 340,000 kw. The new turbine-generator will cost approximately $25,000,000 and will be built by Westinghouse Electric Corp., Pittsburgh, Pa. Work on the new project will begin in the spring of 1962 with completion scheduled for the summer of 1965. Company, which currently has a capacity of 1,384,300 kw, is arranging for the New England Gas & Electric System and New England Gas & Electric Association to take specified amounts of power when the new plant becomes operative.

Morristown, N.J. — Jersey Central Power & Light Co., and its affiliate, New Jersey Power & Light Co., both located in their new headquarters building at Madison Ave. and Punch Bowl Road, have announced plans for the expenditure of $175,000,000 by the end of 1970 for new electric generation facilities for increased capacity and major additions and improvements to transmission and distribution facilities. Plans covering this period include 400 miles of new 230,000-volt transmission lines and an increase from present generating capacity of 606,000 kw to 1,500,000 kw and construction by 1964 of a new generating station in Lacey Township, Ocean County, N.J. Construction program is based on forecasts of future customers increases which utility engineers report doubles every eight years.

New York, N.Y.—Consolidated Edison Co. of New York, Inc., 4 Irving Pl., has plans under consideration for the construction of a large new power plant in this area and has already placed an order with the Allis-Chalmers Manufacturing Co., Milwaukee, Wis., for a turbine-generator capable of producing more than 1,000,000 kw. This is the first time an order for a unit of that size has been placed in the United States. The entire generating plant is expected to cost an estimated $131,000,000 and is targeted for completion early in 1966. New plant will be designed to burn either coal or oil as fuel and will increase company's capacity to more than 7,500,000 kw when in operation. Preliminary engineering work on the project is already under way.

Columbus, O.—Columbus & Southern Ohio Electric Co., 215 North Front St., and Ohio Midland Light & Power Co., Canal Winchester, O., have announced that they have entered into an agreement for the transfer of certain electric utility properties in Ohio and Pennsylvania, in a transaction involving a consideration of $6,000,000. Columbus & Southern Ohio Electric would gain about 8700 customers in the move. Under terms of the agreement expected to be concluded soon, Ohio Midland Light & Power Co. will sell its operations in the towns of

Another addition to the Vogt line of TOP QUALITY valves . . .



Forged Steel
WELDED BONNET

GENERAL GP PURPOSE

Gate and Globe
VALVES

150-800 Pounds Service

To eliminate forever potential body-bonnet leaks, Vogt engineers have developed these new General Purpose valves with seal welded bonnet joints.

This new addition to the world's most complete line of forged steel valves incorporates all the features of other Vogt GP valves—hard faced seats, hardened stainless steel wedges, drop forged pressure parts, and the numerous other advantages of Vogt's valve line.

The desirable safety feature of a back seat on the stem is retained while still offering the elimination of a possible body-bonnet leak.

Available NOW in both gate and globe types, ¼" thru 2", and in both socket weld and screw ends. These are priced identical to the bolted bonnet GP valves; gate valves the same as Series 12111 and globe valves the same as Series 12141.

Address Dept. 24A-FPE for literature

Series 2801 Gate Valve
Illustrated

Series 2821 Globe Valve
Also Available

Both series identical in dimensions and have 13% chrome stainless steel trim.

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SALES OFFICES: Camden, N. J., Charleston, W. Va., Chicago, Cleveland, Dallas, Los Angeles, New Orleans, New York, San Francisco, Seattle, St. Louis.

Vogt GENERAL GP PURPOSE Vogt FORGED STEEL VALVES

FORGED STEEL

VALVES

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Oil burners in California... and coal burners in New Jersey...agree:

Electrostatic Precipitators catch fly ash at Sewaren steam power plant

When DUST is your problem— CLEAR IT WITH WP

For an efficient, economical solution to any dust control problem—look to Western Precipitation. WP is uniquely fitted to handle your unique problem—being the one organization that custom designs, engineers and installs ALL types of dust and fume control equipment: Precipitator, Mechanical, Jet-Cleaned Filter, Hi-Temp Filter, scrubbers and engineered combinations.

With no axes to grind for any one system, WP engineers will give your job a completely unbiased recommendation—whether it's a quote on your specifications, a single component, or a completely engineered installation... small, major, simple, or complex.

An inquiry—on your business letterhead—will bring you literature promptly. Just write Western Precipitation, 1000 W. 9th St., Los Angeles 54, Calif. (In Canada, write 8285 Mountain Sights Ave., Montreal, P.Q.)

Dust and fume control since 1907

***WESTERN PRECIPITATION**

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Division of Joy Manufacturing Company

ELECTROSTATIC Precipitators
MULTICLONE Collectors
CMP Combination Units
DUALAIRE Jet-Cleaned Filters
THERM-O-FLEX Hi Temp Filters
TURBULAIRE Scrubbers
JOY-MICRODYNE Scrubbers
also: **HOLO-FLITE** Processors
HI-TURBIANT Heaters
TURBULEX Calciners

MEMBER OF INDUSTRIAL GAS CLEANING INSTITUTE

Reynoldsburg, Hilliard and adjacent areas to Columbus & Southern Ohio Electric Company and exchange its properties in Groveport and Obetz for Columbus & Southern properties in Ashville, O.

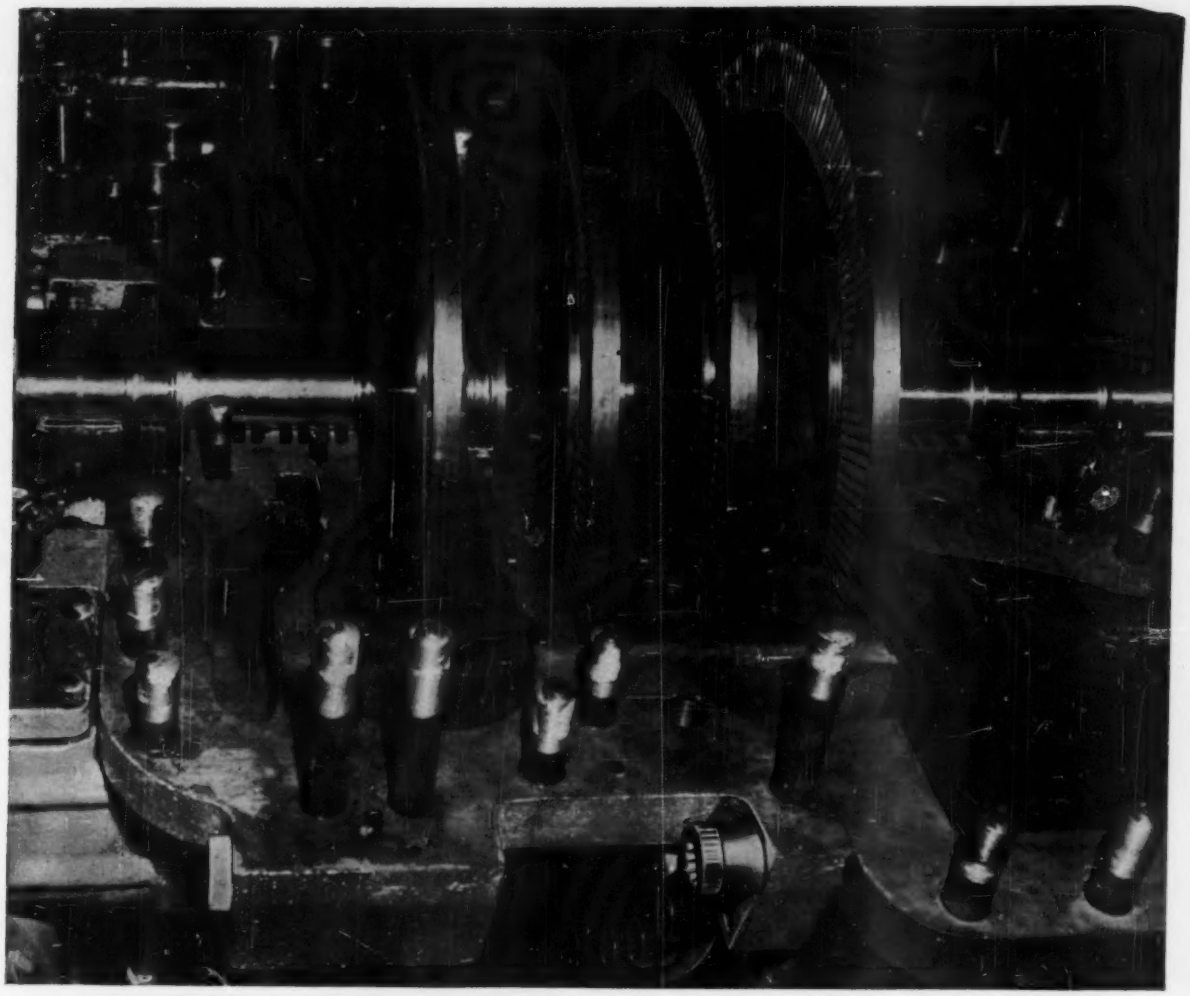
Moncks Corner, S.C.—South Carolina Service Authority has authorized plans for a major expansion and improvement in its electrical transmission and distribution system. Contract in the amount of $1,273,731 has been let to the Richards & Associates, Carrollton, Ga., and Sumter Builders, Inc., Sumter, S.C., for the construction and installation of a 74-mile, 115-kv electric transmission line and a 115-kv switching station serving Berkely, Georgetown and Horry Counties. Work on the project will begin at once and is scheduled for completion by the fall of 1963.

Commerce, Texas—City Department of Light & Power, City Hall, has authorized plans for a major expansion and improvement program in connection with the municipal power plant located here. Plans include the installation of a turbine-generator and auxiliary equipment for considerable increase in capacity. Work will begin at once on the power plant installation, which will cost approximately $557,000. Construction of electric power transmission lines for distribution of new capacity is also planned at a cost of $200,000. Work is scheduled for completion by the summer of 1963.

Goliad, Texas—South Texas Electric Cooperative, Inc., P.O. Box 2178, Victoria, Texas, has authorized plans to construct a new steam-electric generating plant at this location, where a large site has already been selected. Installation will include a steam-electric generating unit with an initial capacity of 44,000 kw, high-pressure boilers, and auxiliary equipment. Cost of the new installation, including the electric repair shop, is estimated to be about $8,000,000. Work is already under way under direction of Roy Krezdorn, Austin, Texas, who is consulting engineer of the project. Plant is expected to be completed sometime in late 1963.

Karnes City, Texas—Karnes County Electric Cooperative has authorized a major expansion and improvement program of its transmission and distribution lines throughout its service area, to cost approximately $400,000. Work will begin soon on the installation of 120 miles of new electric transmission lines, including construction of a new substation at Karnes City, representing an investment of about $275,000. An additional investment of $115,000 will be made at Kenedy, Texas, where company plans to erect an electric substation for increased capacity in that area. Work is scheduled for completion by the spring of 1963.

For more data circle 536 on Post Card



THE INSIDE STORY OF A MURRAY HIGH SPEED COMPRESSOR

DRIVE TURBINE REVEALS THE REASONS FOR MURRAY'S UNIVERSAL ACCEPTANCE

A look at MURRAY'S rugged construction from the inside shows the husky shaft and heavy accurately formed discs with generous sized hubs designed to withstand the axial and radial stresses imposed by this type of service.

Large-dimension disc rims receive the specially contoured stainless steel blades with the Murray integral shroud. This insures smooth steam passages with maximum strength.

Short bearing spans insure smooth operation and eliminate the hazard of operating in critical speeds.

A look at the heavy flanges and husky bolting in the actual unretouched shop photo shown above bears out the extreme ruggedness that typifies every feature of Murray construction.

Our nearest representative will gladly help you solve your high speed compressor drive turbine requirements. Just write to Murray Iron Works Company, Burlington, Iowa, for his name.

Murray
TURBINES

MURRAY IRON WORKS COMPANY • BURLINGTON, IOWA

Builders of Steam Power Equipment for Nearly a Century

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In power installations . . . where the slightest malfunction can mean power failure . . . you find Weinman Pumps the standard for quality, efficiency and dependability of performance. Demand is rigid and constant and Weinman Pumps have proved themselves on the job by instant response and smooth 'round-the-clock operation . . . day after day.

Weinman Type JC Multi-Stage, Split-Case Pumps are especially effective for power plant operation. Designed primarily for direct connection to motors and steam turbines, they can handle a wide range of industrial applications with speed and efficiency.

And, their horizontally split case makes them a favorite of management and maintenance men alike because inspection and routine upkeep of rotating parts is quick and easy without tearing down the entire pump. This results in important cost savings because maintenance and downtime are cut to a minimum.

There's a Weinman Pump to solve *your* pumping problem . . . economically. Just consult your Weinman Pump Specialist for the advice of experience. He's in the Yellow Pages.

For complete information and literature on all Weinman Pumps, write:

THE WEINMAN PUMP MFG CO.
290 SPRUCE STREET COLUMBUS [illegible]
CENTRIFUGAL SPECIALISTS

For more data circle 538 on Post Card

Engineers Meet at Industrial Coal Conference

APPROXIMATELY 100 engineers met at Purdue University, October 11 and 12, to discuss problems related to the use of coal in industrial power plants. Cooperating with Purdue were Mid-West Coal Producers Institute, Inc., National Association of Power Engineers, and National Coal Association.

Protective controls were discussed by J. G. McFarlane of Zurich-American Insurance Companies. Of boilers insured by these companies, 39 per cent of accidental failures and 47 per cent of the total cost of repairs during 1960 were caused by boilers being allowed to operate under low-water conditions.

WATER TREATMENT was described by William F. O'Brien, Jr., of Hagan Chemicals and Controls, Inc. After discussing the various methods of treatment, he emphasized that the chemicals should be added in the proper proportion to follow changing water and load conditions. This requires an adequate testing program and a system of records.

Max A. Tuttle of Pickands Mather & Co. considered the problem of fitting a coal to an existing plant. Criteria considered were methods of car unloading; type of track hopper, conveyors, in-plant storage and hopper chutes; type of draft, grates and stoker; and method of ash removal.

Fitting the New Plant for the Available Coals was discussed by William J. Ganser, chief power engineer at Notre Dame University. In a plant modernization and expansion, three old boilers were removed and replaced with two 70,000 lb/hr units, 450 psi 750 F, with spreader stokers.

S. L. Morse of The Babcock & Wilcox Co. presented a paper on Actual Operating Efficiency versus Efficiency Potential on Coal-Fired Boilers. He made the point that daily efficiency can match test efficiency with normal plant instrumentation, a reasonable boiler maintenance program, and, more important, a good instrument maintenance program.

Papers were also presented on Record Keeping in the Small Plant; Selection and Use of Controls for Small Plants; Progress in Coal-Fired Packaged Boilers, with particular reference to the Gough Stoker; and a report on the use of a Coal-Pak unit for a closed high-temperature-hot-water system. END

NEW MORTON FLUITRON* ASSEMBLY ELIMINATES GRAVEL SUPPORTING BEDS

TAKE THE GRAVEL OUT OF YOUR BRINEMAKER AND KEEP IT OUT!

The all-plastic "Fluitron" is an exclusive Morton brinemaking device which makes possible exceedingly high brine flow rates while *completely eliminating* the need for gravel supporting beds when dissolving high-purity fine grained salts.

When used with Morton '999' or Purex all-soluble salts, the "Fluitron" insures a pure, saturated brine. It diffuses water through the salt bed and also collects the brine for discharge to the brine-use system. And by eliminating the gravel bed and expanding the salt capacity of your dissolving vessel, the "Fluitron" relieves you of frequent salt charging.

*Patent applied for

Adaptable to most brine make-up tanks, the "Fluitron" is included with Morton Model "E" Brinemaker series, or may be acquired individually on convenient leasing terms. Morton Brinemakers are now available in two corrosion-free materials —stainless steel or plastic. Write for complete information today.

☐ *Please send me complete information on Morton "Fluitron" and Brinemakers*

☐ *Please have a Morton Brine Engineer contact me regarding:*

*(type of problem)*_____

Name_____

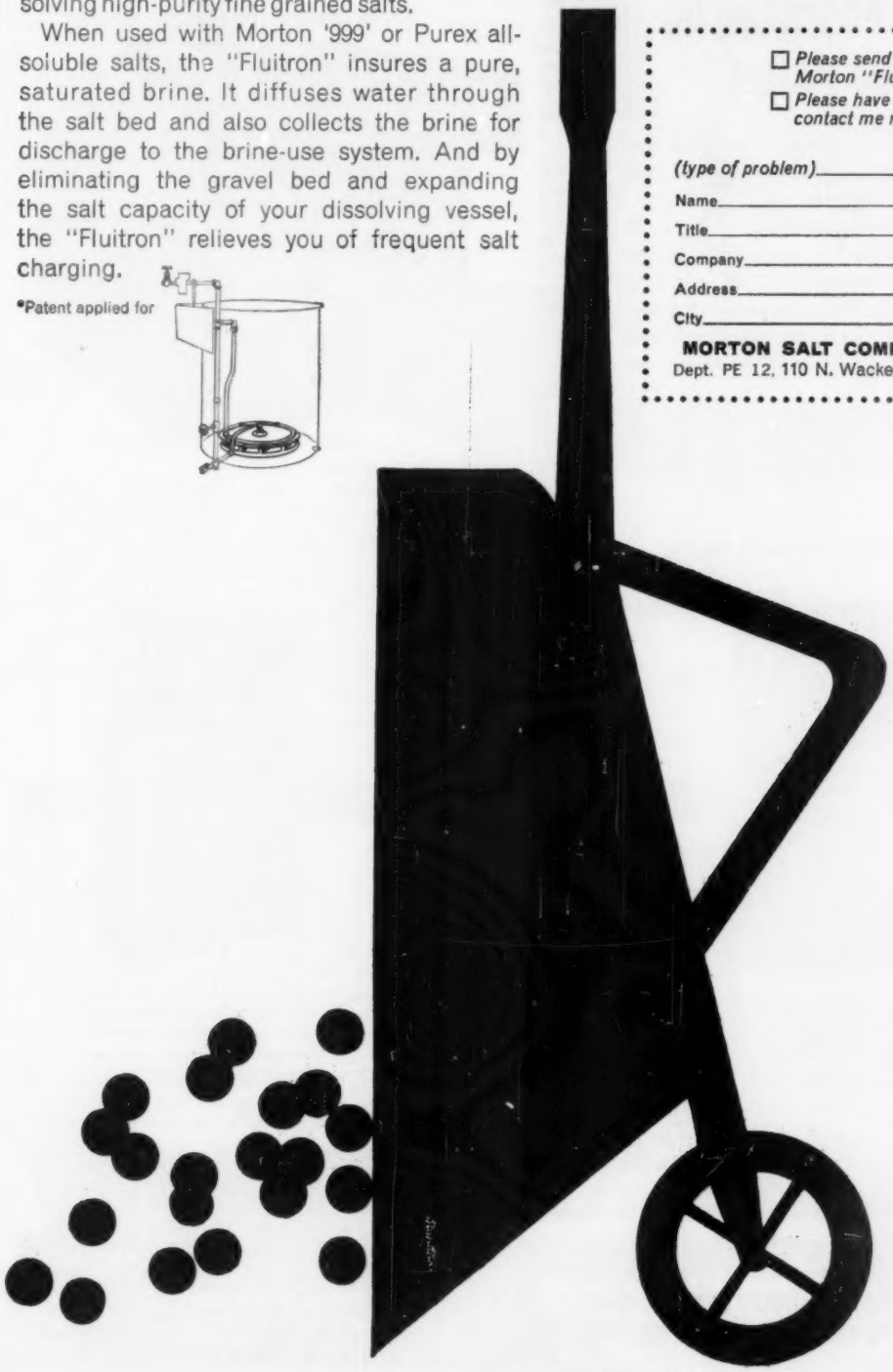
Title_____

Company_____

Address_____

City_____ Zone____ State_____

MORTON SALT COMPANY Industrial Division
Dept. PE 12, 110 N. Wacker Drive, Chicago 6, Illinois



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Here's maximum FLEXIBILITY of CONTROL

in a complete SUPERIOR package

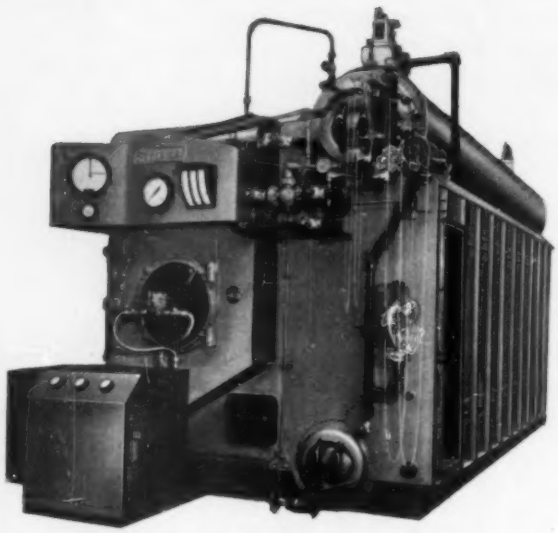
PNEUMATIC *or* ELECTRIC METERING *or* POSITIONING CONSOLE *or* PANEL

Combustion controls tailored to your operation and completely integrated in a Superior Packaged Boiler provide a combination that's hard to beat.

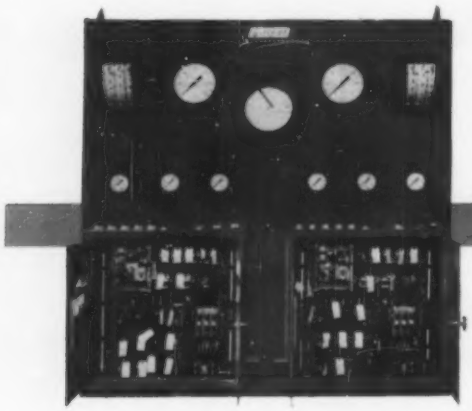
Electrically operated positioning controls for steam or rotary burners are supplied either in console arrangement or free standing panel. Metering controls, either electrically or pneumatically operated, are supplied with steam atomizing burners of all capacities in free standing panels which may be individual for each boiler or combined for two or more boilers.

Safety combustion controls are an integral part of every control panel. Complete factory wiring terminates in a boiler junction box with terminal strip matching identical strip in control panel.

For complete data on Type D Boilers write for catalog D-12

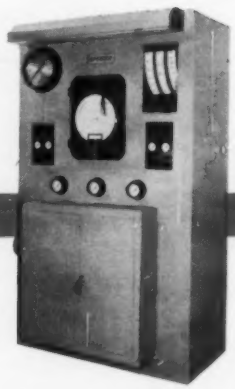


"Type D" Superior Packaged Boiler with integral console for single burners and electric positioning controls.



Duplex panel for two boilers with recording, indicating instruments and individually wired cabinets for combustion safeguard controls.

Control panel with indicating instruments for either rotary cup or steam atomizing burners with positioning controls.



Control and instrument panel with pneumatically operated metering controls for steam atomizing burner installations of all capacities.

Specialists in PACKAGED BOILERS... exclusively

SUPERIOR COMBUSTION INDUSTRIES, INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 36, N.Y.

SUPERIOR PACKAGED BOILERS

For more data circle 540 on Post Card

Current Catalogs

continued from page 36

& Co., tells how this medium can be used for surveillance, transportation and dispatching, and describes the Mini-Camera, able to observe inside a 3-in. pipe. Advantages covered.

Water, Waste Treatment

150 **Water For Peak Loads**—Filtration problem of providing water for peak loads is the subject of B-I-F Industries' "It's a Fact"—a file of bulletins, arrangement and application data. Contains schematics, operation details and engineering data on vacuum filters.

151 **Industrial Waste Treatment**—Problems of waste treatment, classification of wastes and methods of solving these problems are covered in 16-pp Engineering Data Ref. 3-SIC3900.21-1, by B-I-F Industries. Equipment and processes are detailed.

Handling Equipment

152 **All-Electric Cranes** — Bulletin 540, 12 pp, by R. G. LeTourneau Inc., describes cranes for 150- to 16,250-ft tons, with photogrophs showing applications, compactness and design simplicity. Specifications, electrical, mechanical and structural features of each model in the line are given.

When ordering catalogs, allow time for us to relay your requests to the manufacturers — and for them to mail out copies. Remember, manufacturers are often swamped with catalog requests.

153 **For Gentle Lifting**—The Swing Sling that lifts loads safely and without surface damage is described in Bulletin WR-744-5M by The Colorado Fuel & Iron Corp. Types and components are pictured and rated capacities and other data listed.

Other Equipment

154 **Surface Condensers** — Balanced flow surface condensers for use in small turbine drives as centrifugal compressors in air conditioning, auxiliary generators, pump or blower drives are featured in Bulletin 351 by American-Standard, Industrial Div. Materials and specifications included.

155 **Igniter Electrodes** — Oil, gas burner igniter electrodes, glow plugs, flame rods, electric feed-throughs and

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liquid level control electrode with Teflon or alumina insulation are described in 4-pp Bulletin OB6109 by Auburn Spark Plug Co., Inc., with cross-sectional drawings, applications included.

156 **Stud Tensioner** — Six-pp illustrated Bulletin 2606, by Diamond Power Specialty Corp., describes use and applications of the 100 ton stud tensioner. Explains what it does, mechanics of performance operations and advantages. Stud tensioning force capacities are listed.

157 **Fuel Oil Heaters**—Twin G-Fin and Style B fuel oil heaters are described in Bulletin 1416, 12 pp, by The Griscom-Russell Co. Sizes, dimensions and capacities are included.

158 **Tanks and Pressure Vessels** — This 36-pp brochure, by Nooter Corp., on fabrication and field erection services of custom fabricated installations shows behind-the-scene views of machinery, tools, techniques etc. used in construction and erection of units. Examples of products, and typical field-erected projects, are pictured.

159 **Power Plant Paint Selector**— This 16-pp guide, by Tropical Paint Co., aids in selection and proper use of protective coatings on equipment and buildings. Composed of two parts, the first lists surfaces and equipment and suggested paint system for each. The second describes each paint system and discusses surface preparation.

160 **Self-Sealing Fasteners** — High-pressure fasteners for critical applications are featured by A. P. M. Corp. in Catalog H 61. Includes temperature range, pressure range, corrosion-resistence, installation instructions.

161 **Industrial Gas Data**—This 48-pp, pocket-sized booklet by Air Reduction Sales Co. provides industrial gas data in readily-accessble form, listing physical and chemical properties of oxygen, nitrogen, argon, helium and others. Handy conversion tables included, also charts and diagrams giving capacity data on delivery and storage systems.

162 **For Process Industries** — Included in 24-pp Bulletin B-8227 by Westinghouse Electric Corp. are cutaway views and detailed descriptions of multi-valve high-speed mechanical drive steam turbines. System flow diagrams of oil relay governors and single automatic extraction controls included.

163 **Mathematical Handbook**—This 64-pp pocket-sized handbook, by The Curta Co., gives formulas and arithmetical rules for powers, roots, logarithms, decimal equivalents, circular arc tables, mansuration formula etc. Also included are business formulas.

...with new sturdy, reliable Beckman® process pH electrodes

Reduce electrode installation and meter down-time to seconds! Eliminate pulling cumbersome, inconvenient cables through conduits after initial installation! Beckman glass and reference pH electrodes now feature capscrews for quick disconnect of spade lug connectors. Short, rugged, and compact bodies assure longer life in stream service. They're designed to meet the *specific* needs of industrial applications–and built for use with all-new Beckman Model J pH Analyzer and mounting chambers.

- **Glass Electrodes**... available in 3 types to handle all applications–Heavy-Duty General Purpose, Low-Resistance General Purpose, and E-2 Glass. Wide diameter adds strength and provides lowest possible electrical resistance for rapid response.
- **Reference Electrodes**... also available in 3 types for any process application–simplifies selection for stream pressures from atmospheric to 100 psig.

For complete details on these rugged new pH electrodes, plus facts on new Model J pH Analyzer and electrode mounting chambers, contact your nearest Beckman Sales Engineer or write direct for Data File 78-12-16.

Beckman INSTRUMENTS, INC.

SCIENTIFIC AND PROCESS INSTRUMENTS DIVISION

Fullerton, California

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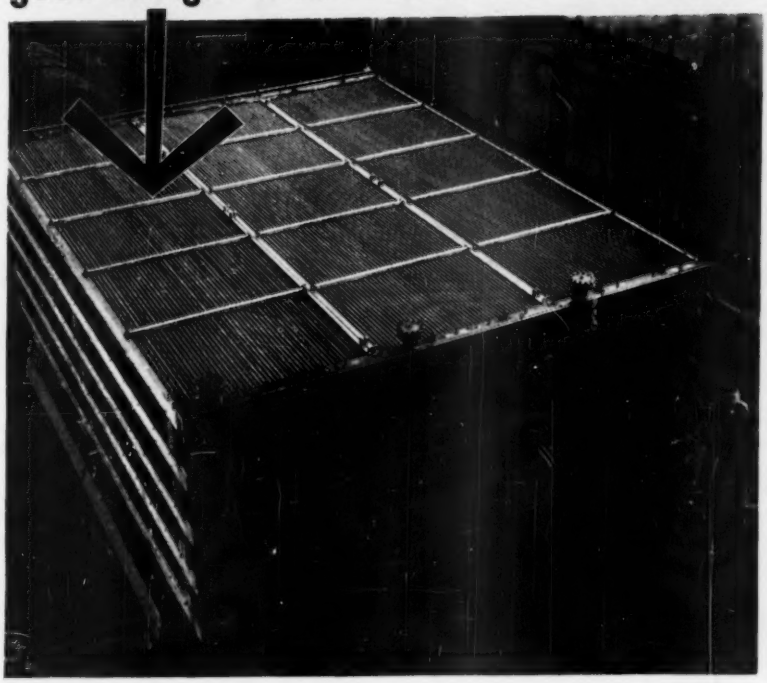
from ALCOA

good designs made better with aluminum



Griscom-Russell designs and builds record heat exchanger with 525 miles of Alcoa Aluminum coiled sheet

World's largest single-cell fin-fan unit, this air-cooled heat exchanger (cut shows cooling sections only) was installed in a major European refinery. Designed and built by Griscom-Russell Co., Massillon, Ohio, it cools heavy hydrocarbon liquid over a 300°F range. Containing 525 miles of Alcoa® Aluminum coiled sheet, the unit has a total cooling surface of 267,000 sq ft. Advantages of aluminum: high thermal conductivity, corrosion resistance and low cost. For more information, please mail the coupon.

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

Aluminum Company of America, 828-M Alcoa Building, Pittsburgh 19, Pa.
Please send me the following literature:

☐ 68-10460 *Process Industries Applications of Alcoa Aluminum*
☐ 34-11566 *Alcoa Aluminum Heat Exchanger Tubes*

Name_____ Title_____

Company_____

Address_____

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Equipment News

Described on these pages are new and improved products. Use Reader Service Cards on pages 89-90 to ask for more information. Just circle item numbers of the products.

1—"Boiler with brain" shows cause of any shutdown

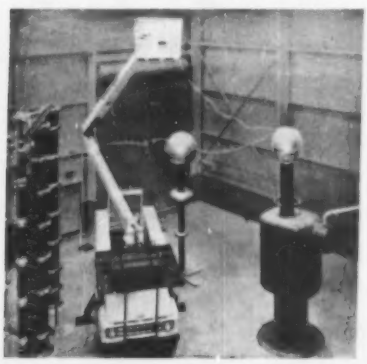
As announced by Clayton Mfg. Co., Model R-175 automatically indicates cause of safety shutdown due to ignition failure, or shortages of water, fuel, electricity or combustion air. It delivers 5000 to 6000 pph steam at high and low pressures, up to 72,000 pph steam or higher in multiple installations. A safety lockout annunciator system operates by means of a group of indicator lamps on control panel of boiler. In case of water shortage, overfiring, excessive temperatures, fuel failure, too-high or too-low oil level, damper failures, or any other factor leading to failure or malfunction, the proper lamp lights to point out cause of burner shutdown.

2—Pipe saddle provides vapor sealing and insulation

Insul-Shield is a multi-purpose pipe saddle designed by Insul-Coustic Corp. to provide a complete vapor seal at the pipe support, as well as the specified insulation thickness and vibration control. Deflection is equal to about 20 per cent of free height depending on insulation thickness. Surfaces are coated with plastic.

3—Aerial lift truck with safety boom of die-molded Fiberglass

Ottawa Strato-Towers with working heights from 35 to 104 ft are now available with a Fiberglas boom designed especially to protect basket crews working on or near electrical transmission and distribution lines. According to manufacturer, Young Spring & Wire Corp., this Fiberglas boom offers superior dielectric qualities as well as outstanding structural strength. The length of pure Fiberglas boom ranges from 11 ft 9 in. to 17 ft 9 in., depending on the height of the unit. The lower end of the boom is steel covered with Fiberglas. Basket leveling controls use Fiberglas rods for isolation and remote hydraulic controls serve to eliminate possibility of fluid contamination that might create a conductor. Pneumatic lines allow use of power tools in the basket. Both one- and two-man baskets can be supplied with these towers.



4—Plastic fishtape can be used in "hot" wiring

This plastic fishtape developed by Cadillac Plastic & Chemical Co. combines non-conductivity with the strength and stiffness of conventional tapes, weighs less and can be carried by one man. Company says it can be used in below-street vaults without hazard, has been tested at 750,000 v with no leakage. Tape is virtually friction-free, enabling it to slide through long packed raceways with less effort. It is designed for use with standard 4-in. and larger ducting and raceways underground where interruption of service is undesirable, as well as rewiring projects where normal service cannot be interrupted. Tape comes in 200-ft lengths, ½-in. diam.

5 — Deaerator reduces oxygen content of boiler water

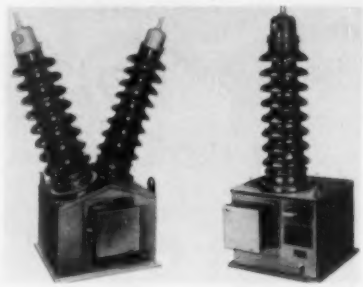
Corrosive oxygen in boiler feed water is reduced to less than 0.005 cc/liter in Boilermate Deaerator developed by Aqua-Chem, Inc. The packed column deaerator spreads the raw water into thin layers by means of a self-cleaning nozzle and tray-type exchange packing. Steam, moving in counterflow to the water, then scrubs out dissolved oxygen and carbon dioxide. Exchange packing material serves as individual trays, exposing a maximum amount of water surface to the steam, yet requires no maintenance. Unit uses automatic variable vent and will operate on waste exhaust steam at 5 lb pressure, as well as on steam from boiler. It comes in models from 1,500 lb an hour at 50 F to 55,000 lb at 150 F. Carbon steel storage tanks hold from 53 to 1,012 gal deaerated water.

6 — Lubricating pastes withstand higher temperatures

Luball, with molybdenum disulfide, and Compound No. 2 are packing lubricants offered by Garlock Inc. for improving the performance of packings. They are resistant to water, steam and chemicals to 500 F, and available in a variety of weights. Bulletin AD-189 gives particulars.

7—Potential transformers for metering, relaying applications

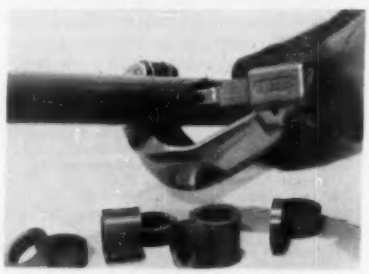
Oil-filled outdoor potential transformers (Type APT), introduced by Westinghouse Electric Corp., are rated at 25 through 69 kv, 150- through 350-kv



BIL. The units are available in single or two bushing design and average 10 per cent smaller and 20 per cent lighter than previous models. The compact design is made possible by using the "solid insulation" principle which eliminates need for oil ducts. These transformers will sell from $80 to $160 per unit less than the type they supersede.

8 — Cutting wheel for plastic pipe leaves no burr

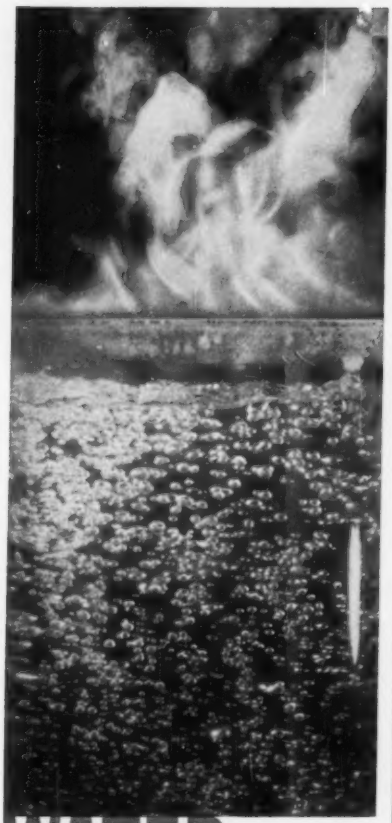
This cutting wheel converts The Ridge Tool Co's No. 205 Tubing Cutter into a plastic pipe cutter in a matter of seconds. For use on thin or heavy wall



rigid plastic pipe (up to 2 in. Schedule 120 pipe, ¼-in. wall thickness), wheel is designed to give a perpendicular cut, and to leave no internal or external burrs to interfere with distribution of solvent in making up a joint.

9—Relief valve has adjustable spring-actuated diaphragm

Spring-loaded, diaphragm-actuated Type E Relief Valve (No. 1910R), by Atlas Valve Co., is designed to give tight closing for pressures to 300 psi/



WATER FOR BOILERS NEEDS DEOXY-SOL

- to remove O_2
- reduce oxides
- raise pH

Fairmount DEOXY-SOL, a solution of hydrazine, is a high efficiency oxygen scavenger designed especially for high pressure boiler water treatment.

DEOXY-SOL removes oxygen, reduces oxides and raises pH of the condensate all at the same time . . . yet adds no solids.

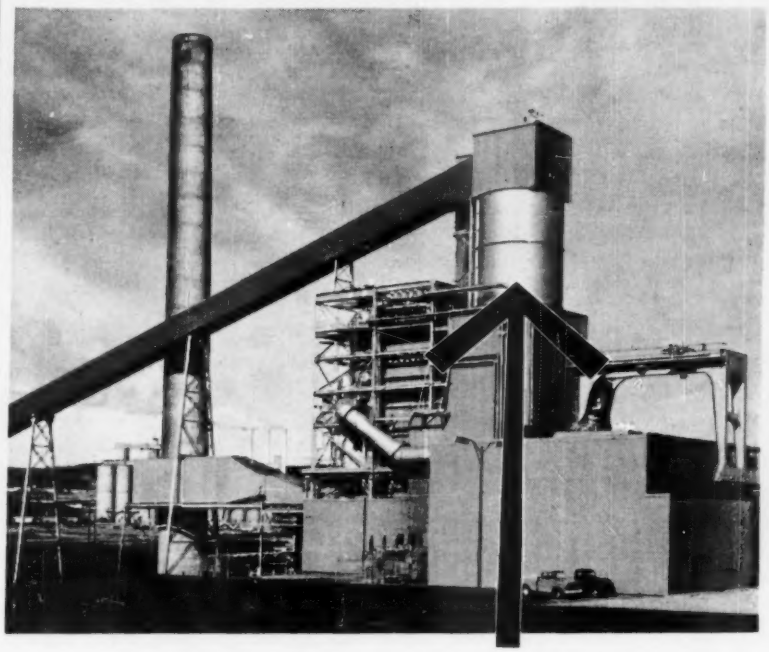
Stocks in Newark, N. J., Chicago, Ill., Los Angeles, Calif. Investigate its advantages for your system. Write for Bulletin PE.

Fairmount
CHEMICAL CO., INC.
136 Liberty St., New York 6, N. Y.

For more data circle 543 on Post Card

from ALCOA

good designs made better with aluminum



Stearns-Roger Manufacturing Co. designs Ben French Station with Alcoa Aluminum boiler lagging

The growing trend to outdoor boiler construction created a demand for a strong, lightweight, corrosion-resistant covering material. Aluminum is ideal for this application, as handsomely demonstrated by the new Ben French Station, Black Hills Power & Light Co., Rapid City, S.D. Boiler lagging of Alcoa® Aluminum was designed and installed by Stearns-Roger Manufacturing Co., Denver, Colo. In addition to improved function and appearance, aluminum saves money because painting is eliminated. For more information, please send the coupon.

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

Aluminum Company of America, 828-MM Alcoa Building, Pittsburgh 19, Pa.

Please send me the following literature:

☐ 17-11135 *To Produce More Kilowatts per Dollar . . . Alcoa Aluminum for Generating Stations*

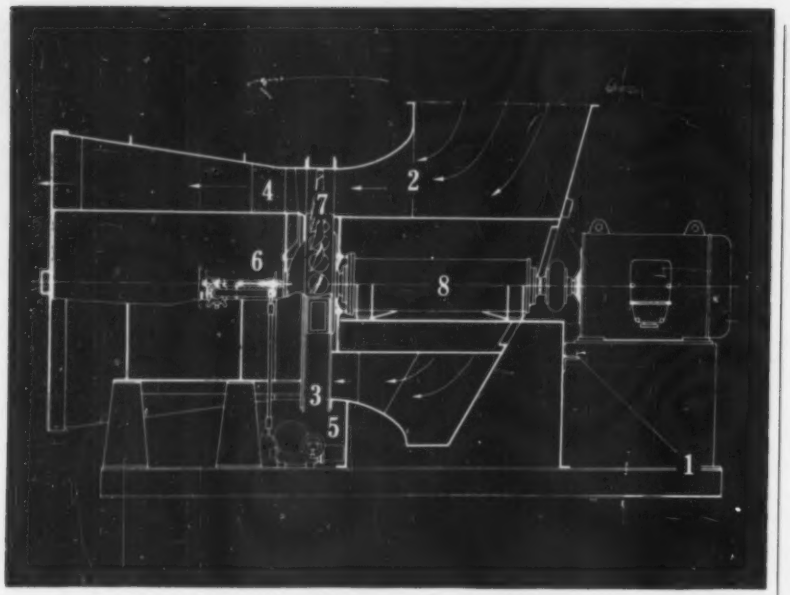
Name_____ Title_____

Company_____

Address_____

City_____ Zone_____ State_____

For more data circle 544 on Post Card



VARIAX...The busiest axial flow fan in the industrial countries of the world

1 *Base frame with motor support.*
2 *Inlet box and inlet cone.*
3 *Housing.*
4 *Diffuser with fixed guide vanes.*
5 *Servomotor.*
6 *Blade adjustment mechanism.*
7 *Fanwheel.*
8 *Main bearing assembly.*

You name the country and we'll name the Variax installations. In utilities, industrial plants, government projects – wherever space is at a premium and a fan *fully controllable during operation* is needed – you'll find a Variax model at work. Capacity range is from 50,000 to 1,100,000 cu. ft/min. Designed in accordance with the latest aerodynamic principles, the Variax blade angle can be varied during operation to give optimum results and minimize losses. The short overall length of the Variax fan facilitates its easy, straight-forward incorporation in boiler plants and other installations. The Variax is ideal for parallel working. Parts and service facilities are maintained for this American fan and a full engineering staff can answer all your questions. Please write for full literature and the booklet "Axial Flow Fans for Boiler Draught Requirements" to:

NOVENCO INC.

VARIAX

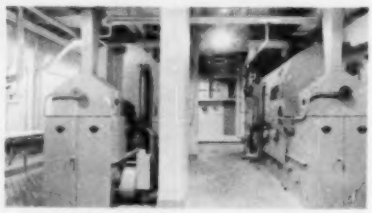
40 Exchange Pl., New York, N.Y.
Tel. HA 2-5470

For more data circle 545 on Post Card

wog, at temperatures below 180 F. When pressure, sensed under its spring-loaded diaphragm, exceeds that for which the spring is set the diaphragm moves up, opening the relief valve. Unloading pressures, adjustable by a single screw, range from 5-55 psi to 100-250 psi. Features include cast iron body with nickel alloy or stainless steel trim, renewable valve disc and 'O'-ring construction. Available in six sizes from ½ to 2 in.

10—Packaged coal boiler offers automatic operation, fuel saving

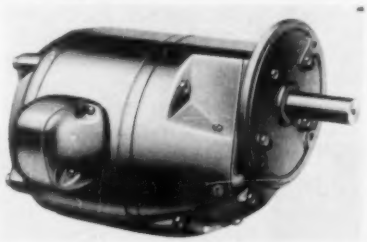
Developed by Canton Stoker Corp. for industrial use is the Powr-Matic a fully automatic, bituminous coal-fired packaged steam generator in sizes from 70 to 300 hp. Stoker, integrated control system and coal and ash conveyors are part of the "package." Operation is controlled by changes in



load demand. At the suggestion of a bin level control, coal is transferred from the bin to a storage hopper at the front of the boiler. Electronic controls attached to the steam or hot water lines signal the stoker mechanism to feed fuel. When boiler needs are met, controls cause stoker equipment to slow down or stand by until more fuel is needed. At the rear of the furnace, ash is dribbled into an enclosed container or conveyed outside the building. The unit can be operated at 10 to 100 per cent capacity. Combined with converter, it can air condition a building. Two units are shown — any number may be operated in tandem. Bulletin 161 gives details.

11 — Footless gearmotor for direct-connection to machine

The footless Type GH Unimount Syncrogear of U. S. Electrical Motors, Inc., retains the same features as the foot-mounted type, such as asbestos-protected windings, normalized castings, and precision-honed gears and solid shank high speed pinions. Only the slower speed gears dip into the oil reservoir, providing efficient lubrica-



LARSON-LANE STEAM AND CONDENSATE ANALYZERS

FOR ACCURATE MEASUREMENT OF STEAM CONDUCTIVITY

MOST modern and efficient system of removing volatile amines, ammonia and carbon dioxide prior to recording steam conductivity. This thoroughly effective steam degasser uses a cation exchange resin for the removal of ammonia, morpholine, cyclohexylamine, and reboiling for the removal of CO_2. Constant sample temperature is maintained. Taps provided for drawing sample for other analyses.

Larson-Lane Steam and Condensate Analyzers make possible rapid and accurate measurement of steam purity, completely essential for efficient boiler operation.

A smaller, less expensive unit, the CH-16 provides for removal of ammonia and amines from steam condensate without the necessity of reheating. Condenser leakage is readily detected with this model in the presence of volatile amines or ammonia.

Write today for complete technical details.

Industrial Instruments Inc.
89 Commerce Road, Cedar Grove, Essex County, N. J.

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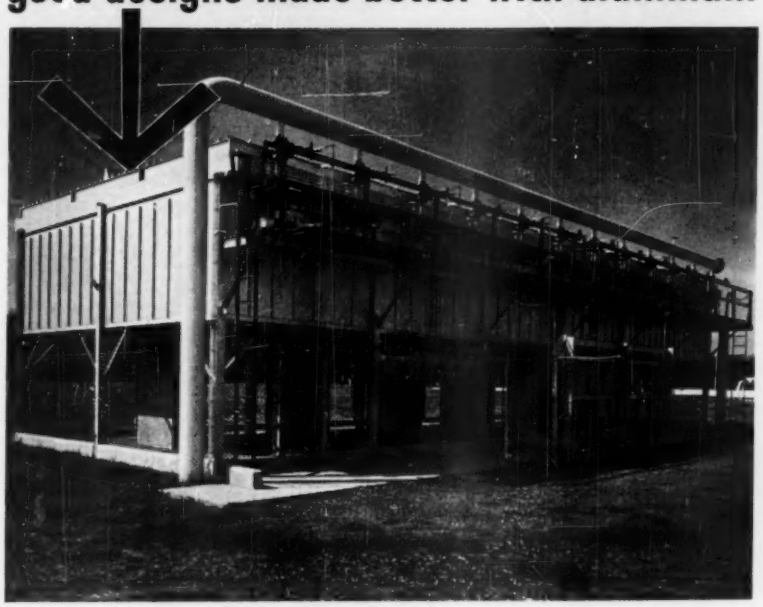
from ALCOA

good designs made better with aluminum



Griscom-Russell heat exchanger has aluminum fins for improved gas engine cooling system

This fin-fan heat exchanger cools gas engine jacket water at the Paris, Tenn., plant of American Louisiana Pipeline Co. Similar units are installed at the Shelbyville, Ind., and Greenville, Miss., plants, all designed and built by Griscom-Russell Co., Massillon, Ohio. Cooling fins, of special G-R design, are made of Alcoa® Aluminum. High thermal conductivity combined with natural resistance to corrosion, ease of fabrication and low first cost made aluminum the logical choice of material. Perhaps Alcoa Aluminum can improve your good design. For more information, please send the coupon.

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

Aluminum Company of America, 828-Z Alcoa Building, Pittsburgh 19, Pa.

Please send me the following literature:

- ☐ 34-11566 *Aluminum Heat Exchanger Tubes*
- ☐ 34-10197 *Aluminum Pipe and Fittings*
- ☐ 42-20849 *Resistance of Aluminum Alloys to Weathering and Resistance of Aluminum Alloys to Chemically Contaminated Atmospheres*
- ☐ 61-21088 *Aluminum Cooling Towers and Their Treatment*

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Company_____

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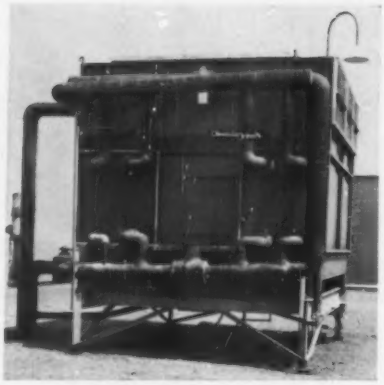
The Most Reliable, Long-Lived Cooling Equipment



● Every day this Niagara AIR-COOLED Heat Exchanger is adding $90 revenue while its owner's plant is in operation, from savings in the cost of cooling water.

For more than thirty years similar machines have been making such savings in industries all over the country. They do not wear out, are easy to keep clean and cost little for upkeep. Panel construction makes all parts accessible. Cleanable coils are available.

With the Niagara Aero® Heat Exchanger you have a closed system of cooling, free from dirt. Heat is removed at the rate of input, making it easy to control temperatures. The heat is dispersed into the atmosphere by means of evaporation of a very small amount of water, solving the problems of cooling water supply and disposal.

Write for bulletins 120 and 132.

NIAGARA BLOWER COMPANY

Dept. E-12, 405 Lexington Ave., New York 17, N. Y.

Niagara District Engineers in Principal Cities of U.S. and Canada

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The World's Fastest Tube Bending Service

Most complete stock of boiler tubing anywhere

•

Bent Tubes fast for any make or size of boiler

BOILER TUBE COMPANY OF AMERICA

McKEES ROCKS, PA. (Pittsburgh District) Federal 1-7750

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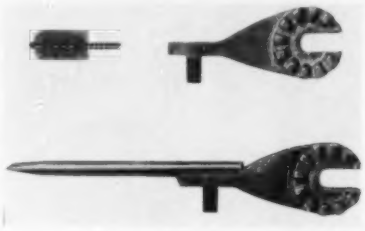
tion without churning. Available from 1 to 5 hp, 230 to 780 rpm, with NEMA style C or D brackets in 9- and 10-7/8-in. face plates, respectively, in drip-proof, totally-enclosed and explosion-proof designs.

12—Low-cost device eliminates interference with radio-TV

Introduced by Erie Fan & Blower Co., Inc., this unit is designed to eliminate arcing in Johnson dead end insulators, the most frequent cause of power line interference with radio and TV reception. Arcing takes place across gaps



in the insulator joints created when corrosion forms on metal parts. Device consists of a small brush with phosphor bronze bristles and brass wire core. Inserted in the insulator, the bristles pierce the corrosion and make an electrical bond between the metal parts. An inserting tool and a spreading tool (shown with the brush) facilitate installation.

13—Silicon-bronze welding rod for most processes

Air Reduction Sales Co.'s Airco 1010, a silicon-bronze welding rod for use with tungsten insert-gas, carbon arc and oxyacetylene welding processes, will weld silicon bronze wrought and cast material, weldable grades of copper and copper alloys and plain and galvanized steel. Rods are 36-in. long.

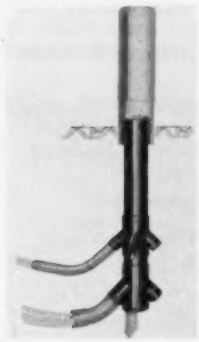
14—Equipment removes water and acid from transformers

By condensing and removing water and volatile acids from transformers, Westinghouse Electric Corp.'s Condensaire reduces deterioration of oil, maintains dielectric strength and reduces corrosion. Equipment consists of a metallic inverted coneshaped hood assembly for bolting on existing

hand-hole cover boss. A heavy gasket insulates this hood from transformer cover so that hood is always cooler than cover. Vapor rises to cool hood and condenses, then is piped to container at lower level.

15—Conduit riser adapter for secondary distribution systems

This conduit riser adapter of Line Materials Industries provides a convenient means of terminating conduit



in power pedestals for above-ground connection of secondary services to mains. Prefabricated of bituminized fiber, the assembly provides for leakproof junction of four 2-in. conduit runs for secondary services, and two 3-in. conduit runs for secondary main interconnection.

16—Pressure gage shows tank levels, pressure drops

A differential pressure gage with a 60 psi scale and 3000 psi working pressure is introduced by Pall Corp. It is

designed for hydraulic oils, phosphate esters, lube oils, and fuels. Accuracy is given as ±2 per cent; temperature range is —40 to 200 F. It operates by a magnetic coupling, without mechanical linkage.

17 — Electronic sensing meter needs no direct wire contact

Easy-to-read meter indication of voltage from energized power lines, without direct wire contact, is said to be provided by the low-cost Voltage Proximity Indicator of Wintronics, Inc. Its transistorized circuits, actu-

from ALCOA

good designs made better with aluminum

Bright, maintenance-free aluminum ductwork covering throughout—specified by Stearns-Roger for new Ben French Station

Insulated gas ducts, air ducts, air heaters and fan housings were covered with Alcoa® Aluminum to achieve a modern, attractive appearance and a surface that never needs attention. It is aluminum covered ductwork throughout at the new Ben French Station—installed by Stearns-Roger Manufacturing Co., Denver, Colo., for Black Hills Power & Light Co., Rapid City, S.D. Aluminum sheet is easy to fabricate by conventional sheet metal methods, reports Stearns-Roger. Moreover, it pays off through the years with undimmed appearance and no maintenance. For more information, please send the coupon.

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

Aluminum Company of America, 828-ZZ Alcoa Building, Pittsburgh 19, Pa.
Please send me the following literature.

☐ 17-11135 *To Produce More Kilowatts per Dollar . . . Alcoa Aluminum for Generating Stations*

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Company _____

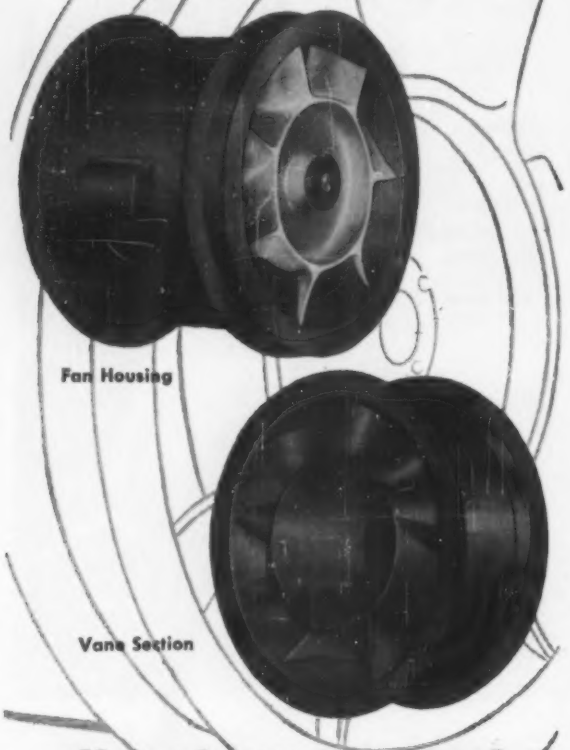
Address _____

City _____ Zone _____ State _____

For more data circle 550 on Post Card

another outstanding design development from

Aerovent



direct-connected
vaneaxial
fans

with removable vane sections

Engineered for high-pressure, high-velocity air distribution systems, these units feature a unique removable vane section which simplifies installation and permits easy access for routine cleaning and maintenance.

Available in 30 models in sizes 18" to 48" for capacities from 3230 to 67,300 cfm with special design features for all application requirements.

Write for Bulletin 475

Air deliveries of all Aerovent equipment are tested and rated in accordance with established and accepted codes and each unit is guaranteed by the manufacturer to deliver its rated performance.

CERTIFIED PERFORMANCE

Aerovent

Aerovent

FAN COMPANY, INC.

ASH AND BRUSH STREETS PIQUA, OHIO

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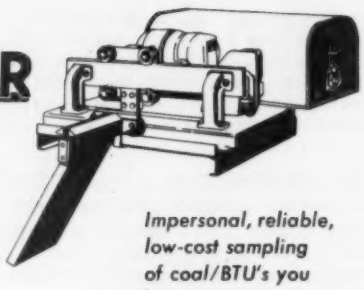
DENVER



AUTOMATIC SAMPLERS

Impersonal, reliable, low-cost sampling of coal/BTU's you buy or sell.

COMPLETE LINE OF SAMPLING AND SAMPLE PROCESSING EQUIPMENT

Wet, dry and dust-tight units. Simple, reliable, automatic. Units with cutter travel to 10' and longer. New bottom-dump dry cutters (patent pending) for use where headroom is 10."

Dimensioned layout drawings and specifications sent on request.

NEW... 30"/sec. Cutter Speed

reduces bulk of material taken — often eliminates cost of secondary sampling—without affecting reliability of sample.

DENVER EQUIPMENT COMPANY

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For Greatest Savings in Pumps Get a Dean Brothers GS

Here is the pump that put *service* back into pumps. And with Dean Brothers exclusive service parts policy, no worry about down time waiting for obsolete replacement parts... there are no such things. One day delivery. Consult yellow pages for nearest representative, or wire, phone or TWX direct for fast dependable service.

Type GS Standard Centrifugal Pumps
For general, industrial and chemical service
Capacity: to 300 gpm @ 1750 rpm—to 600 gpm @ 3500 rpm
Head: 20 to 80 ft @ 1750 rpm —80 to 300 ft @ 3500 rpm
Pumping Temperature: —150° F to plus 350° F
Working Pressure: to 180 psig @ 350° F

For Full Information Ask for Circular 190

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS 7, INDIANA

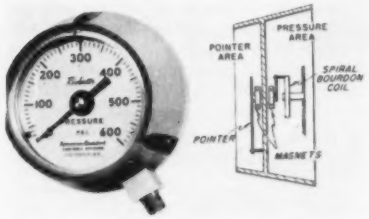
The Best Is Our Standard

For more data circle 553 on Post Card

ated by an electrostatic field surrounding power lines, are claimed to have sufficient sensitivity to distinguish "hot" from ground lead, and to trace and indicate location of circuit failure. Safety features announced include positive voltage indication for normal 110v a-c and higher.

18—Solid-wall gage designed to end explosion hazard

A heavy cast aluminum wall separates pressure and pointer areas of Model 5130 Safety-Wall Gage, designed by American-Standard Controls Div. to



eliminate gage glass explosions. It uses a magnet attachment to spiral-wound bourdon coil, with magnet attached to coil on one side of the wall and pointer with another magnet on the other side. Pointer moves in response to pressure demands through magnetic attraction. Usual wear points such as links, pivots, gears or hair springs are eliminated and failures and maintenance reduced. Gage pressure ranges to 10,000 lb. The gage has a 3½ in. dial, is designed to provide accuracy of ½ of 1 per cent of full scale range. Technical Data Sheet 90-44 gives details.

19—Power Package for mobile or stationary applications

Announced by Bristol Siddeley Engines Ltd., this "power station on wheels" is a complete generating unit—gas turbine power plant, generator and controls—housed in a single 3 megawatt power package which can be transported by semi-trailer, flat-car, or be lowered to any level site for stationary use without special foundations or buildings. The compact turbo-generator is powered by a gas turbine engine, and is said to cost less than other generating sets of similar capacity. Generators provide sufficient power each to supply a town of 10,000;

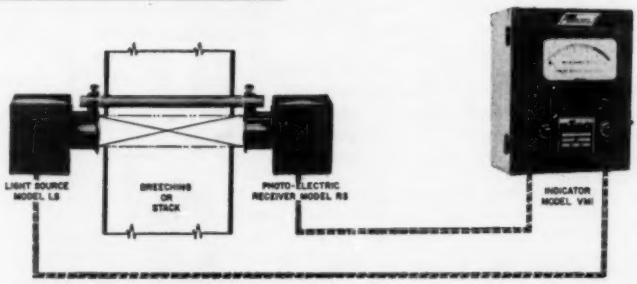
CLASSIFIED ADVERTISING

THERMAL POWER STATIONS
PROJECT SUPERINTENDENTS
ASSISTANT PROJECT SUPERINTENDENTS
Civil - Mechanical - Electrical
START AND TEST ENGINEERS
SHIFT OPERATORS
LOCATION FAR EAST
Qualified applicants submit résumé to
THE KULJIAN CORPORATION
Construction Division — Dept. B
1200 N. Broad St. — Philadelphia 21, Pa.

CLEAR UP THIS PICTURE AT AMAZING LOW COST

AND SAVE FUEL DOLLARS

Reliance Smoke Density Meters and Alarms are unsurpassed for versatility. They succeed where others fail. They monitor boilers, incinerators, air conditioning ducts — they mount almost anywhere, simply and accurately—and they indicate, record, sound alarm and control burners, air jets, fans, etc.



Check these features which mean trouble free equipment:

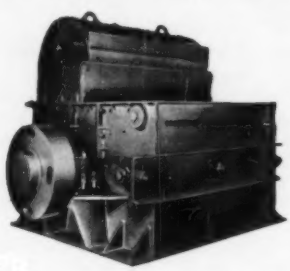
- Compensated electronic circuit—no voltage regulator required.
- Simple, inexpensive installation. Unique mounting brackets assure permanent alignment and minimum dust problem.
- Rugged industrial components designed for extra long life.
- Only three simple steps to set equipment in operation.
- Standard units include:
  Clear or excess smoke signal lights
  Terminals for alarm or recorder
  Ringelmann meter indicating smoke density
  Compensator for dust accumulation
  Sealed beam light source—good for years of service.
- Added options:
  Plug-in Time delay relay
  Recorders
  Agents are located across the nation.
  Call or write for bulletin on our complete line of automatic combustion controls.

RELIANCE INSTRUMENT
(formerly RIMCOR)
Division of **ELECTRO-MECH** Corp.
500 Livingston St., Norwood, N. J. • POplar 8-5770

For more data circle 555 on Post Card

This GRUENDLER CRUSHER handles

600 TONS OF COAL PER HOUR WITH EASE!



This is one of a complete line of Gruendler machines for crushing and conditioning coal for cyclone burning. Specified by many consulting engineers because:

Lower original cost
Lower maintenance
Top performance and production

GRUENDLER CRUSHERS ARE BEST

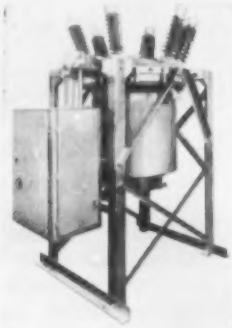
Write for Bulletin 154
GRUENDLER CRUSHER & PULVERIZER CO.
2915 N. Market • St. Louis 6, Mo.

For more data circle 554 on Post Card

are controlled by telephone from a central station and need no permanent operating staff. When used for peak-lopping and similar intermittent duties, a visit every few months and an overhaul every 10 yr is claimed to be all the maintenance required. Fuel systems include kerosene, diesel fuel and natural gas.

20 — Oil circuit breaker in single-tank 69-kv unit

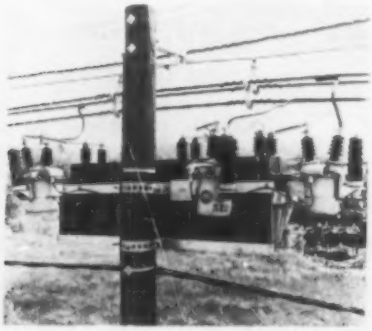
This subtransmission oil circuit breaker by I-T-E Circuit Breaker Co. incorporates a Kool-Arc vertical interrupter for efficient, safe three-phase interruption in one tank. For utility



and large industrial use, it offers lower installation costs and maintenance savings over conventional three- tank breakers of the same rating. All three phases are contained in one steel tank, and a single top frame supports internal parts and bushings. This eliminates cross members, and permits easy access to internal parts when tank is lowered for inspection or maintenance. Single tank breakers are available in 14.4 to 69 kv, 500-1500 mva, 1200 amp continuous.

21 — Capacitor bank is completely self-contained

Westinghouse Electric Corp.'s Autotrol provides power factor correction and voltage regulation at or near the load, complete with built-in lightning arresters and fuse protection. Unit is rated from 150 to 1200 kvar and can handle fault currents to 4000 amp symmetrical, limited only by 100-amp fuse ratings. Fusing costs are claimed



less than one-third of fusing with open type, and installation cost is reduced — no separate cross arm required.

22 — Hydraulic aerial beam reaches between high power

Nicknamed "The Little Guy," this aerial beam by McCabe-Powers Body Co. is a smaller version of company's

Sky-Master. It is a budget-priced unit enabling one man to reach over parked and moving cars and between telephone and power lines. Spirex outer beam and molded fiber-glass basket are insulated for protection from high voltage lines. Hydraulic remote controls for operating outer and inner beams are located on mast. Ground-to-basket heights are 30, 32 and 35 ft.

23—Portable electronic speaker carries voice loud and clear

Although powerful enough to carry the voice 500 ft, this low cost and lightweight transistorized power megaphone can be modulated for shorter

distances for outdoor or indoor use. A product of Edmund Scientific Co., it sells for around $13.00. The compact case is impact-resistant plastic and power is supplied by four D cell flashlight batteries (not included).

24—Master pressure controller for multiple boiler installations

Reliance Instrument Div., Electro-Mech Corp. announces a master pressure controller capable of maintaining ± 2 per cent operating range from 15 to 2000 psi. It utilizes a K Monel bourdon tube as the primary sensing element. Operating with electronic balanced-bridge control circuits, it may contain up to nine master sending potentiometers, enabling it to control nine boilers from a common header, and permits load balancing or base loading as required. The same controller, with a filled bourdon tube system, may be used as a temperature controller over the ranges from 200 F up to 1000 F.

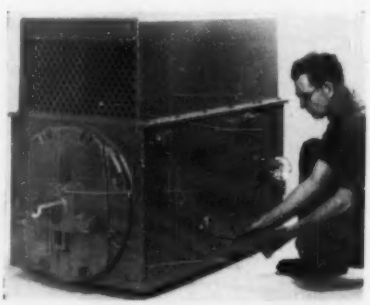
25 — Union-coupling permits quick make and break

Being a union in itself, Quikupl, introduced by Cooper Alloy Corp., affords simple and quick disassembly and reassembly with an ordinary wrench. Low in first cost, it minimizes expense for systems requiring frequent disassembly. Coupling is designed for metal and plastic pipe and tubing ½ to 6 in., provides straight-through unrestricted flow and puts only a gasket

of approved material in contact with fluid. It consists of a cylindrical connector piece into which pipe, tube or fitting ends fit and which acts as a bearing surface and assures proper alignment. Pipe, tubing or fitting ends are held by a nut against a Neoprene or Teflon gasket.

26 — TEFC motor available in lower horsepowers

Cooling tubes mounted in a removable air-to-air heat exchanger provide effective ventilation for General Electric Co.'s 8000 Motor. Available from 300 hp and up at 1800 rpm, it is designed for use in chemical processing plants or in contaminated atmospheres. Internal fan circulates air across outside of tubes in heat exchanger. Ambient air blown through inside of tubes removes heat from the motor. External



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(† *Caskey and Harding,* American Power Conference, 1957).

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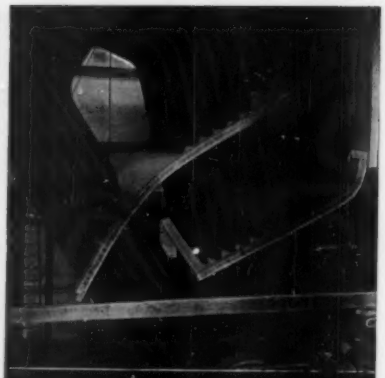

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1. provide two water columns, one at each end of the drum — a gage on each.
2. one water column having two sets of gage connections; use "twin" gages.
3. one column at one drum end, and a direct-to-drum water gage assembly at the other.
4. two direct-to-drum assemblies, one on each end of the drum.
5. use one conventional gage, either direct-to-drum or on water column, and two manometric-type remote gages (the Reliance EYE-HYE) if operating over 900 psi. (Case No. 1155.)

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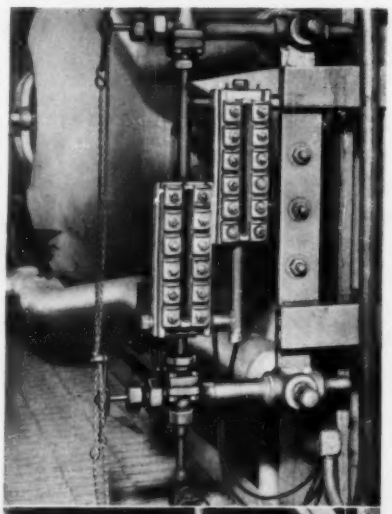

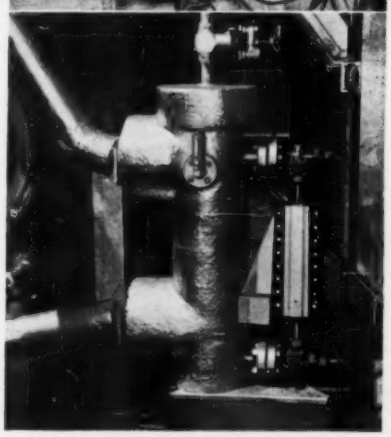

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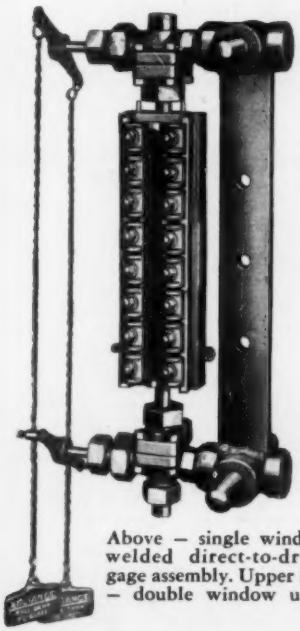

Above — single window welded direct-to-drum gage assembly. Upper left — double window unit.

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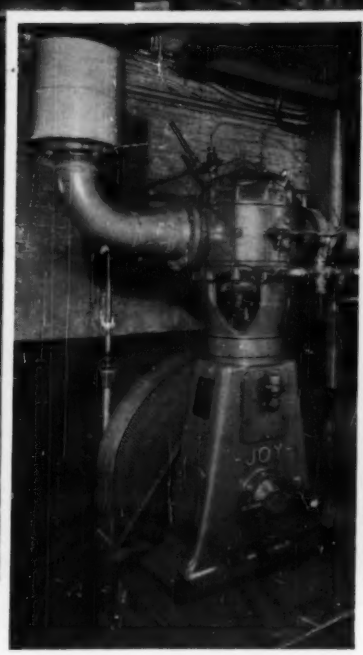


Paper making machine at Rising Paper Company plant at Housatonic, Mass., one of the few paper mills in the country producing only high grade specialty papers.

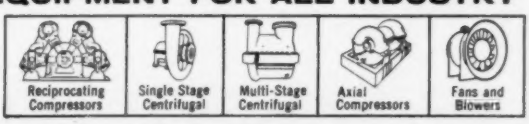
This JOY Oil-Free Compressor at Rising Paper Co. has paid for itself in barely a year of operation!

A drop of oil can ruin hundreds of feet of expensive specialty paper at the Rising Paper Company plant in Housatonic, Mass. Or, it can necessitate a costly shutdown if it gets into the air cylinders or instrumentation. By providing oil-free air with month-in, month-out reliability, the Joy WGOS-9 has literally paid for itself in the time it has been in operation. Equipped with Teflon rings, it has shown savings on compressor maintenance, in addition to the really big savings in air cylinder and instrument maintenance on the papermaking machinery.

Joy's exclusive T-Block design makes possible the long ring life which is essential for low cost oil-free air. Many other "big compressor" features, such as force-feed lubrication, replaceable cylinder liners and crosshead guides, and anti-friction main bearings, make the Joy WG-9 Compressors outstanding in their size range.

Whenever you need low cost standard or oil-free air, it will pay you to consult your Joy representative. The Joy line includes reciprocating compressors from 10 to 2000 hp., and centrifugal and axial compressors from 15 to 25,000 hp. For complete information on the WGOS-9 Compressor, write for Bulletin 3043-56C.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



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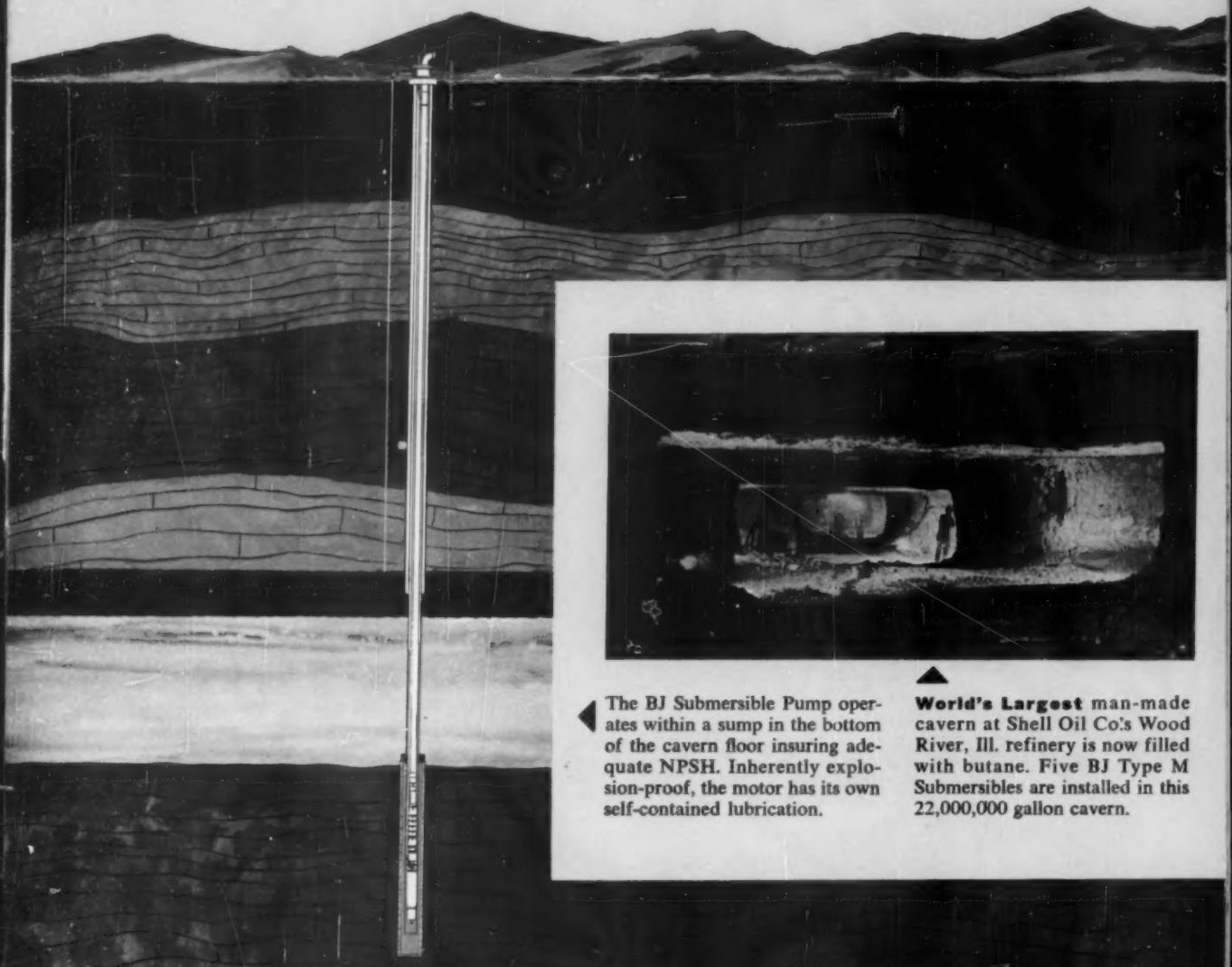
BJ Submersible Pumps for Underground Cavern Storage...



The BJ Submersible Pump operates within a sump in the bottom of the cavern floor insuring adequate NPSH. Inherently explosion-proof, the motor has its own self-contained lubrication.

World's Largest man-made cavern at Shell Oil Co.'s Wood River, Ill. refinery is now filled with butane. Five BJ Type M Submersibles are installed in this 22,000,000 gallon cavern.

Underground cavern storage of Liquid Petroleum Gases has not only proved practical, but economical (approximately 20% of the cost of conventional surface storage).

To meet the special requirements of this service, Byron Jackson has developed the Type "M" Submersible Pump. Using an oil filled, mechanically-sealed submersible motor, and a deep well bowl assembly designed especially for handling LPG, this pump has been proved in seven different cavern installations using a total of 14 pumps.

Sizes of these BJ Submersibles range from 4 to 16 stages, delivering from 40 to 800 gpm and rated at from 25 to 200 horsepower.

For a technical bulletin giving complete information on pump selection, installation and construction, plus a list of users, call or write BJ today!

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